Aalto University
School of Engineering

Mea Ylä-Soininmäki

Impact of Connectivity on Sustainable Development

Master's thesis, which has been submitted for Master of Science degree.

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Supervisor: Professor Olli Varis
Advisor: LLM, MA, Timo Kolehmainen

Aalto University
School of Engineering

Aalto University, P.O. BOX 11000, 00076 AALTO
http://www.aalto.fi/en/

Abstract of Master's thesis

Author Mea Ylä-Soininmäki		
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Abstract

Connectivity has changed the world for good, and its impact will only increase in the future. Connecting people, and due to *Internet of Things* (IoT), connecting devices have created and will continue to create various opportunities for individuals, industries and the society. This has a major impact on sustainable development, and it provides solutions that may help improve the economic, social and environmental fields.

In the economic field, connectivity and access to the Internet have enabled distance working and various new business opportunities. Connectivity and ICT may increase GDP, generate massive financial benefit and lift people from poverty in developing countries. With the IoT, the industries' efficiency and productivity may improve and time may be saved.

In the social field connectivity enables e.g. studying regardless of people's physical location and helps improve health and digitalize healthcare. It may help save millions of lives and allow people to contact almost anyone, anywhere, anytime. In addition, it has eased life in many ways on a daily basis in convenient and entertaining ways.

The impact of connectivity on the environment is also massive, and the potential to help prevent climate change is great. Connectivity-enabled resource efficiency and dematerialization, again, help replace physical products with services. In the future, ICT may help abate CO_2 emissions by much more than it will generate by its deployment. Connectivity and ICT may help decouple economic growth from emissions growth.

There will also be challenges and some clear risks. Because of the digital divide, many people are still unable to benefit from connectivity and ICT. Automation may make some jobs disappear in the future, and privacy protection will create some risks for individuals and society. Due to the IoT, energy usage will increase and the numerous devices in the IoT require materials as well. Connectivity must also be reliable; it enables many everyday businesses to operate.

All in all, the positive impact is enormous and exceeds the negative impact. The potential that connectivity has is extremely vast, and it should definitely be exploited. Ultimately, connectivity has the potential to create benefits in every field of sustainable development simultaneously: it may very likely create a win-win-win situation.

Keywords Impact, Connectivity, ICT, Sustainable Development, Environmental, Social, Economic, Risks, Challenges, Solutions, Health, Privacy, Safety, Education, Livelihood, Freedom of Speech, Resource Efficiency, Internet of Things, IoT, 5G, SDG, CO2

Aalto-yliopisto
Insinööritieteiden
korkeakoulu

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www.aalto.fi
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Tiivistelmä

Konnektiviteetti on muuttanut maailmaa pysyvästi, ja sen vaikutus kasvaa tulevaisuudessa yhä. *Internet of Things* (IoT) eli asioiden Internet yhdistää ihmisten lisäksi esineitä, jotka voivat kommunikoida keskenään. Tämä luo valtavasti mahdollisuuksia ihmisille, teollisuudelle ja yhteiskunnalle. Potentiaali vaikuttaa kestävään kehitykseen (talous, sosiaalinen puoli, ympäristö) on erittäin suuri.

Taloudelliset vaikutukset ovat merkittävät. Konnektiviteetti ja ICT luovat uusia liiketoimintamahdollisuuksia. Ne voivat auttaa nostamaan BKT:tä ja nostaa ihmisiä köyhyydestä etenkin kehitysmaissa. IoT voi auttaa kehittämään monien prosessien ja teollisuudenalojen tehokkuutta ja tuottavuutta sekä säästää merkittävästi aikaa.

Sosiaaliset hyödyt ovat hyvin laajat. Konnektiviteetti mahdollistaa opiskelun sijainnista riippumatta, voi auttaa lisäämään ihmisten terveyttä ja digitalisoi terveydenhuoltoa. Se voi välillisesti pelastaa miljoonien ihmisten hengen monella eri tavalla, ja antaa ihmisille mahdollisuuden yhteydenpitoon lähes kenen kanssa tahansa, missä ja milloin tahansa. Konnektiviteetti parantaa elämänlaatua myös monia käytännön asioita helpottamalla.

Ympäristövaikutukset ovat myös suuret, ja konnektiviteetti voi auttaa torjumaan ilmastonmuutosta; tulevaisuudessa sen aikaansaamat CO_2-päästövähennykset ovat moninkertaiset sen omaan tuotantoon nähden. Konnektiviteetin avulla resurssi- ja materiaalitehokkuus auttavat korvaamaan fyysisiä tuotteita palveluilla. Potentiaali talouskasvun ja päästöjen kasvamisen yhteyden katkaisemiseksi on suuri.

Konnektiviteetti aikaansaa myös haasteita. Suuri osa ihmisistä on yhä ilman Internet-yhteyttä, ja siten hyötyjen ulottumattomissa. Automaatio korvaa osan työpaikoista, ja tieto- ja yksityisyydensuoja voivat epäonnistuessaan muodostaa suuren riskin. IoT taas lisää energiankulutusta ja edellyttää paljon materiaalia laitteiden määrän vuoksi. Konnektiviteetin tulee myös olla luotettava; yhteyden katkeaminen voi muodostaa riskin.

Tulokset osoittavat, että positiiviset vaikutukset ovat ylivoimaisesti negatiivisia suuremmat, ja konnektiviteetin potentiaali on erityisen merkittävä. Sitä tulee ehdottomasti hyödyntää kestävämpää tulevaisuutta luodessa, sillä konnektiviteetin avulla on mahdollista aikaansaada höytyjä kaikilla kestävän kehityksen osa-alueilla samanaikaisesti: lopputulos on erittäin mahdollisesti win-win-win-tilanne.

Avainsanat Vaikutukset, Konnektiviteetti, ICT, Mobiiliverkot, Kestävä kehitys, Taloudellinen, Sosiaalinen, Ympäristö, Riskit, Haasteet, Ratkaisut, Terveydenhuolto, Yksityisyys, Turvallisuus, Koulutus, Elinkeino, Sananvapaus, Resurssitehokkuus, Internet of Things, IoT, 5G, SDG, CO2

Acknowledgements

My master's thesis has been written for Nokia, as the Corporate Responsibility team expressed its interest in researching the impacts of connectivity in the different areas of sustainable development. In the fall of 2015, I was happy to begin my thesis.

Obviously, the subject of this thesis is very relevant to today's world, especially since numerous people and things will be connected through the IoT in the future.

Possible opportunities are unlimited when connectivity is concerned, and the impact is already massive. The main goal of my thesis was to discover the impacts of connectivity regarding sustainable development: what type of positive impacts and risks are and may be in the economic, social and environmental fields in the future. Also the sub-fields are taken into consideration.

I would like to thank Nokia and the CR team for the two excellent summers I spent there, as well as for offering me the opportunity to write my master's thesis in such an interesting topic. I really couldn't have imagined a more fascinating subject. In addition to Nokia, my thanks go to Maa- ja vesitekniikan tuki ry for funding this thesis.

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Espoo 30.4.2016

Mea Ylä-Soininmäki

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Abbreviations

AAC	Augmentative Alternative Communication
AV	Autonomous Vehicles
CIA	Central Intelligence Agency
CO_2	Carbon dioxide
CO_{2e}	Carbon dioxide equivalent
DID	Dissociative Identity Disorder
DRR	Disaster Risk Reduction
EKG	Electrocardiogram
EU	European Union
FBI	Federal Bureau of Investigation
GeSI	Global e-Sustainability Initiative
GPS	Global Positioning System
GRI	Global Reposting Initiative
ICT	Information and Communications Technology
IEA	International Energy Agency
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
MEA	Middle East and Africa
MIM	Mobile Instant Messaging
NGO	Non-Governmental Organization
NHTSA	National Highway Traffic Safety Administration
NSA	National Security Agency
OTT	Over-The-Top
PwC	PricewaterhouseCoopers
RPM	Remote Patient Monitoring
SDG	Sustainable Development Goals
SMS	Short Message System
TFP	Total Factor Productivity
U.S.	United States
UN	United Nations
VR	Virtual Reality
WWW	World Wide Web

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1 Introduction

1.1 Background

In the world of today, there is significant potential for an impact on sustainable development through connectivity and information and communications technology (ICT). Technology is already integrated in our everyday lives, and its amount will only increase exponentially in the future through the Internet of Things (IoT) and the Programmable World, which means that almost everything will be connected. The IoT is a network and it will connect electronical physical things, like machines, cars and mobile devices that have the ability to communicate with each other and exchange and collect data.

This provides exceeding opportunities for sustainable development and all its sub-fields. According to the GeSI's report called *#SMARTer2030: ICT Solutions for 21st Century Challenges*, ICT may break the link between economic growth and the growth of emissions, and connectivity should be the driver for the future of global development (GeSI, 2015).

Connectivity itself means interaction between both people and people and people and machine, and thanks to the IoT, also interaction between machine and machine. Connectivity and ICT are strongly interlocked, and depending on the area ICT is used in, it may for instance allow the use of cloud technology and create new possible opportunities for areas that are still in developmental stages. (Nokia Networks, 2015a & Nokia, 2016d.)

Furthermore, connectivity enables people to access information from all over the world when it is needed; to contact almost anyone, anytime, anywhere; and people to have their voices heard. Smart cities may be more sustainable, and autonomous vehicles (AV) may save lives as well as reduce emissions (Anderson et al., 2014 & Nokia Networks, 2015b).

The balance of economic, social and environmental fields is crucial for our society, as society aims to secure a good quality of life for the people of today as well as the next generations (Ympäristöministeriö, 2015). Cooperation is important in order to maximize positive impact and minimize the negative: the United Nations' 17 Sustainable

Development Goals (SDGs) (Figure 5) aim to transform our world by 2030. Connectivity and ICT enable many of these SDGs to improve sustainable development in various ways (Accenture, 2015).

The ICT's and, by extension, connectivity's great potential lies in helping other industries to improve in sustainable development (GeSI, 2015). They therefore contribute highly to the achievement of those goals as well. It is, for example, possible to generate substantial economic benefit, improve peoples' health and decrease CO_2 emissions by almost ten times the amount than ICT generates; ICT is crucial in preventing climate change (GeSI, 2015).

There are also challenges regarding connectivity and ICT, and they need to be taken into account in order to minimize future risks. For example, privacy protection has gained lots of attention and data security is more and more important. Identifying risks beforehand presents the opportunity to diminish the negative impact and prepare for the changes.

In the end, connectivity is a vital part of people's lives, and it has changed the world for good. In addition, ICT transformation has all it takes to improve people's lives (GeSI, 2015). The possibilities to improve numerous areas seem to be limitless, and the positive outcome that creates a more sustainable world is remarkable.

1.2 Nokia

Nokia was founded in 1865 as a single paper mill operation and it celebrated its 150th anniversary in spring 2015. The company has gone through a transformation from a rubber factory to a world-leading mobile phone manufacturer and further to next-generation services and technology. (Nokia, 2016a & Nokia, 2016b.)

In January 2016, Nokia began combined operations with Alcatel-Lucent, a French telecommunications equipment company. After the acquisition, Nokia serves customers in over 100 countries and has 104,000 employees globally in five business groups: *Mobile Networks, Fixed Networks, IP/Optical Networks, Applications & Analytics* and *Nokia Technologies*.

Nokia's business focus is on network equipment and wireless technology. According to Nokia's President and CEO Rajeev Suri (Nokia, 2016e), the vision for Nokia's future lies in a Programmable World where physical objects have computing power, sensors and connectivity built in them. The Programmable World requires connectivity to be able to handle all of these devices and the exponentially increasing demand for data traffic (Ministry of Foreign Affairs of Finland, 2014). Moreover, 5G, IoT and the Cloud demand extraordinary capabilities from the network (Nokia, 2016).

According to Suri (Nokia, 2016c), "*We are already seeing how the combination of billions and billions of connected devices and sensors, linked to cloud-based analytics that drive automated and intelligent action, can do extraordinary things. Smart cities can be more liveable, sustainable cities. Autonomous driving can save lives and reduce emissions. Remote health care can reduce costs and improve well-being. The list can, and does, go on".*

"Bringing these benefits more to life to more people requires many things but two most of all. First is access to connectivity everywhere. Not just connectivity, but connectivity that is both affordable and capable of meeting the needs of the use cases of the future. – – The second thing needed is to break down the barriers that block easy and fast adoption of high-speed broadband connectivity". (Nokia, 2016c.)

In terms of beneficial useful technology, Nokia targets sustainable development as well as social and economic growth. Useful technology may be determined by different requirements, but at the very least it includes access to high performance and capacity broadband networks and covers the area widely in inexpensive way for people to access. (Nokia Networks, 2015a & Nokia, 2016d.)

1.3 Aim and Scope of the Study

The aim of this master's thesis was to research the impact of connectivity in environmental, social and economic areas in the fields of connectivity and ICT. They are significant to Nokia, because "Nokia's radio networks customers serve approximately 5 billion subscriptions worldwide" (Nokia Form 20-F, 2016). ICT and connectivity have changed the world in many ways in sustainable development area and their sub-fields.

Because the company's current focuses, that is to say mobile broadband, networks and ICT, the potential to make a change is extremely vast (People and Planet 2014, 2015).

This thesis is divided into different sections that specify each of the impact areas. The study concerns connectivity and ICT, and the impacts are considered from the 1990s to present day. A strong view of the future is included to be able to recognize how connectivity and ICT will change the world and what may be the expected positive impacts of this change. Due to sustainable development, the impact areas are economic, social and environmental. These areas have been divided into sub-fields in order to specify and clarify the analysis. Past, present and future are integrated into the text to describe the most relevant impacts that have already occurred or may do so in the future.

Many of these impacts are related to several fields as they are not unambiguous. The same subject may therefore be mentioned more than once in order to identify the impacts on various different levels. As an example, there are socio-economic impacts regarding access to information, which is therefore examined both in the economic and the social section.

In addition to researching the positive impacts, this thesis also identifies changes and challenges that have already occurred or might do so in the future in the economic, social and environmental areas. Even though some of these changes are unavoidable, not all of them are necessarily negative, such as the mixing of cultures. It is still important to identify the changes and challenges to be able to see the big picture and minimize future risks.

Ultimately, the conclusions of this research are presented on each of the three dimensions of sustainable development. The results of each field are first presented separately and finally together to demonstrate the discoveries concerning the impacts' relatedness. This allows Nokia and other parties to recognize the topics that are most relevant to them. The aim is to vicariously help these parties to recognize how to prevent negative impacts and how to participate in sustainable development in a manner that aims to create even more positive impact. Finally, the summary wraps up the impacts and conclusions.

2 Measuring the Impacts

2.1 Interviews and Researches

In order to identify the impacts as reliably as possible, the results of this study are justified with expert statements and scientific studies. The interviewed experts were both from inside Nokia and from non-governmental organizations (NGOs) outside the company. This made it possible to gain the most encompassing and holistic picture, regarding the important details as well.

I interviewed almost 30 professionals between fall 2015 and spring 2016 to discover the most significant impacts and challenges regarding connectivity and ICT in all the areas relevant to this thesis. Using professionals from many different fields was necessary in order to receive valid and scientific facts. The interviews began with open-ended questions after which the questions were specified to collect the information needed from the fields of the interviewee's expertise. I made comprehensive and exact notes on all of the interviews. Many of them were also recorded for transcription. The duration of the interviews varied from 30 minutes to two hours, depending on the subject and its relevance.

The research and studies used in this thesis are scientific and comprehensive. In addition, some of the literature is from books, articles and other publications, and in many cases the information has been verified from many sources. Some news articles were also used in order to reflect the impacts on current occurrences in the world of today.

Due to their qualitative nature, some impacts are harder to measure unequivocally than others. They are therefore explained with various relevant research papers, studies and expert statements on the subject as well. As an example, environmental and economic impacts may usually be calculated quantitatively based on the amount of savings in currency or on CO_{2e} emissions abatement, while social impacts often have no comparable methods of measurement.

An array of research and studies were used to reflect the expert statements. Using comparable information from many independent sources increases the reliability of the

impacts studied, especially in cases where the impacts cannot be measured unambiguously.

2.2 Conducting the Renewed Materiality Analysis Tool

In 2014, Nokia decided to revise the company's focus to materiality and revise the materiality analysis. Due to the changed business scope, Nokia's responsibility strategy is based on the analysis, as is also their target setting. I took part in conducting the analysis by creating a new materiality analysis tool for Nokia.

With it the company is now able to identify the topics most important for them, for sustainable development and for the company's stakeholders. The target is to innovate methods of using technology in a way that makes tomorrow more sustainable, which Nokia's technology of mobile broadband and networks make possible.

I used Microsoft Excel 2013 to create the tool, which ranks the topics according to the weighted points given to different factors under each topic. The materiality tool analyzes the scores and the outcome is presented in a materiality analysis graph. In it, the *Importance to Nokia's business* (x-axis) and *Importance to sustainable development and stakeholder interest* (y-axis) are shown on a scale from low to high. The topics in the materiality analysis are economic, social and environmental.

According to the results, the highest importance to both Nokia's business, sustainable development and the stakeholders' interests *is Improving people's lives with technology* (Figure 1). This topic had almost maximal points in both axes. It also addresses the importance of the topic of this thesis, both for Nokia and for other parties.

This master's thesis also covers many of the other topics found in the analysis (Figure 1). For example, in second place is *Nokia's direct economic impact*, and the other top topics also include privacy and energy efficiency of Nokia's products. Energy use or energy efficiency are mentioned in three of the ten topics in the analysis in total, which shows the importance and relevance of them in the world of today. Both consumers and stakeholders are more and more environmentally conscious, which is why it is important for companies to be able to meet the increasing demands.

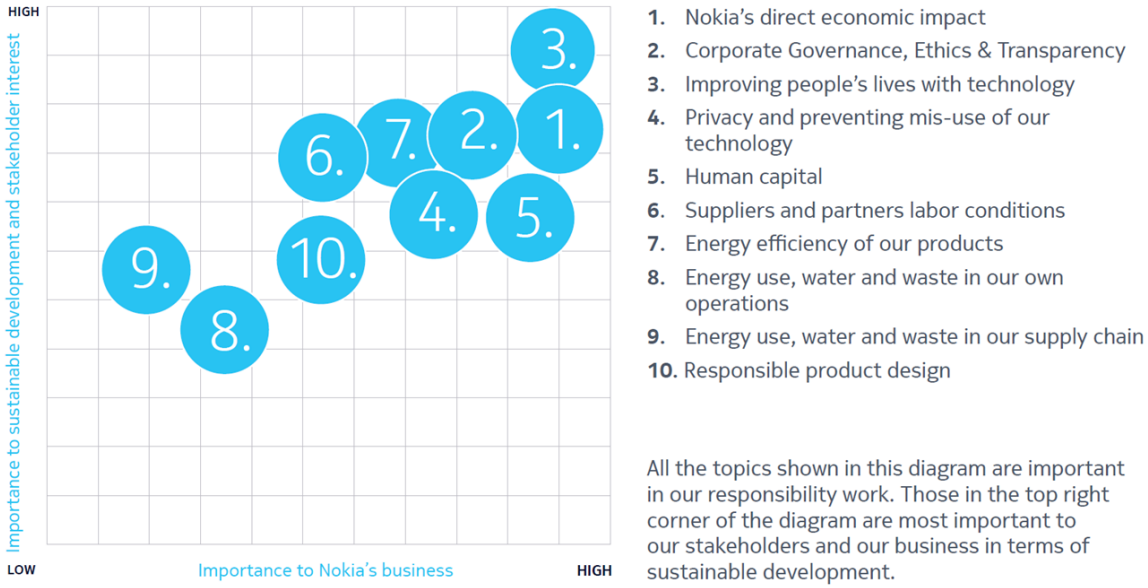


Figure 1, Materiality Analysis (Nokia Networks, 2015b).

Furthermore, Nokia has announced that the key trends affecting its responsibility work are the following: *The human potential of technology in a Programmable World; Increased importance of Privacy; Demand for high ethics and transparency; the importance of attracting and retaining talent; Climate change* and *Need for better resource efficiency* (People and Planet 2014, 2015).

3 Positive Impact of Connectivity on Sustainable Development

3.1 Connectivity and ICT Improving People's Lives

According to Oksanen (2015), connectivity is the most remarkable thing Nokia has brought into this world. In order to build a true global information society, everyone must have equal access to ICT by accessing the technologies and information. Nokia provides access to the Internet and therefore knowledge, which benefits billions of people and creates opportunities in societies all over the world (Figure 2). The company is also focusing on solving the challenges that prevent access to ICT.

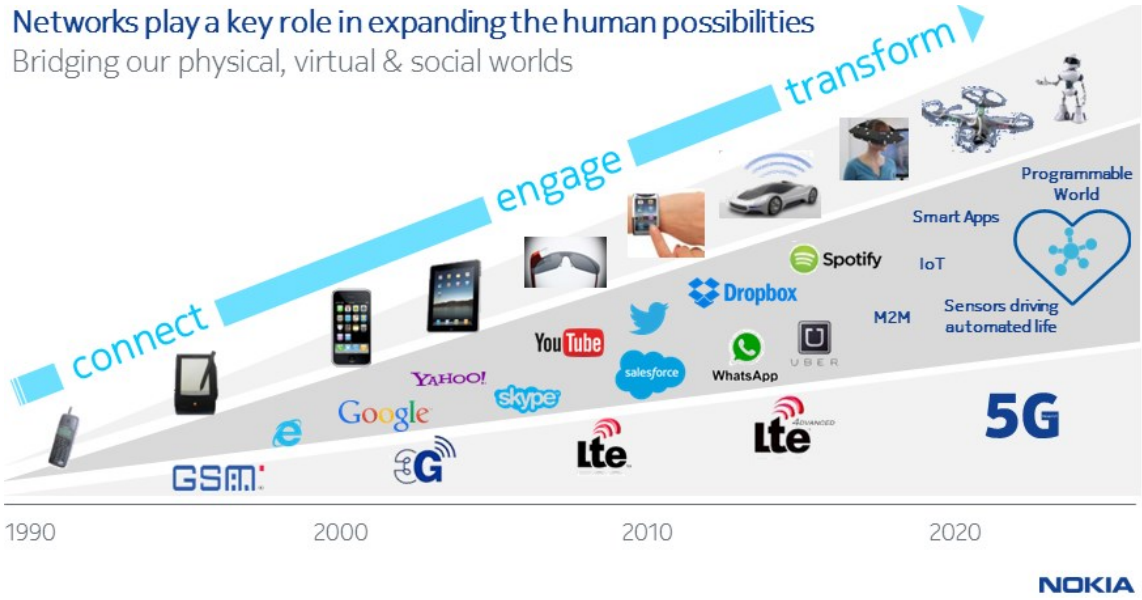


Figure 2, Nokia Infographic. Networks as enabler for connecting, engaging and transforming the world. (Nokia Technology Vision 2020, 2015).

By creating social value and business value simultaneously, it is therefore possible to create shared value. Nokia aims to do this by identifying key sustainability topics and by creating value for both people and the planet as well as for the company itself (Figure 3). These factors form the basis of Nokia's sustainability strategy. (Nokia Sustainability Report 2011, 2012 & People and Planet 2012, 2013). Therefore, Nokia is committed to using technology in a way that makes it possible to contribute to economic and social

progress while helping to reduce different industries' negative environmental impact (People and Planet 2014, 2015).

Moreover, according to Professor Michael E. Porter (Shared Value Initiative, 2016), corporations' purpose should be redefined. By creating shared value instead of only profits, it would be possible for the global economy to drive innovations and productivity growth.

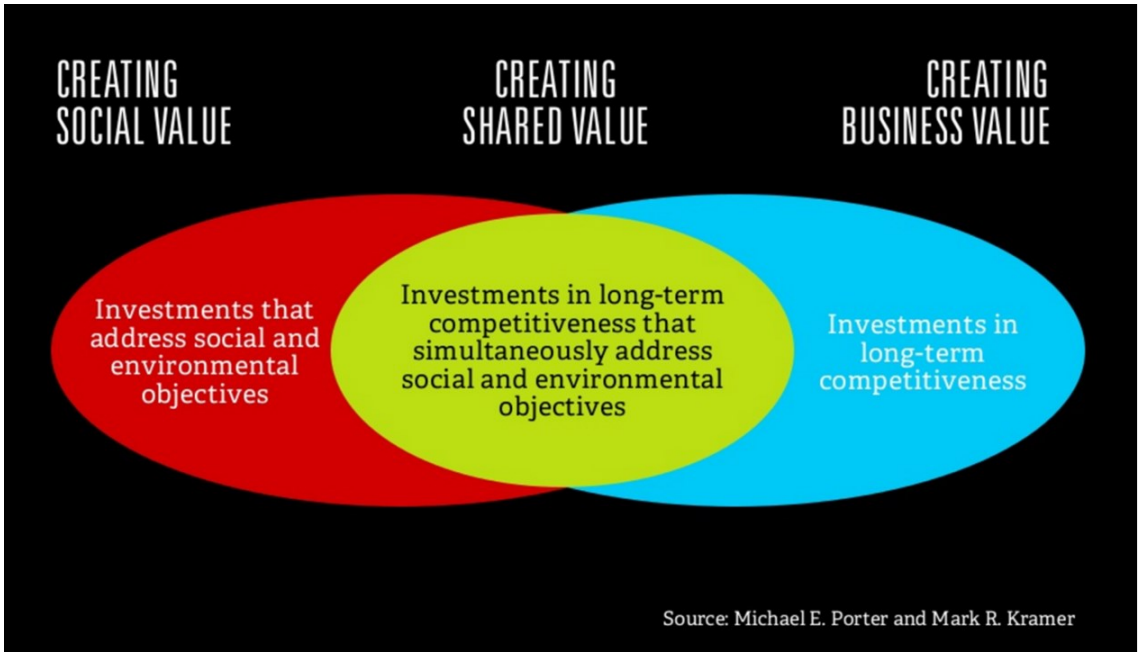


Figure 3, Creating Shared Value (Bemporad et al., 2013).

The positive impacts that connectivity and ICT enable are very diverse and they reach every area of sustainable development. According to Ministry of Foreign Affairs of Finland (2014), Rajeev Suri states that the Programmable World will improve lives in many ways through data that is processed in the cloud and creates new services. This type of data might be, for example, about cars and medical devices.

Furthermore, according to Demos Helsinki (2015), this type of hyperconnected planet is already here, and many more technologies will become a part of people's daily lives as well as their surroundings. It will also reshape the relationships between people and the physical world we live in, as well as affect communities, societies and economies.

According to Luis Neves (GeSI, 2015), Chairman of Global e-Sustainability Initiative (GeSI), ICT is fundamental to the counteraction of climate change and it can separate economic growth from emissions increase. According to him ICT can also improve people's lives, which is why connectivity should drive development globally.

GeSI's (2015) report #SMARTer2030 identifies the possibilities ICT has for sustainable development. The report shows that ICT is going to significantly reshape the world of today, and in 2030 the world will be run through ICT to the large extent. Because of it, the world will, for instance, be healthier and cleaner, and there will be greater possibilities for individuals, and savings both in the environmental and economic fields. As an example, in the future ICT may help prevent emissions almost ten times more than will be generated by its deployment. (GeSI, 2015.)

ICT enables the economy to develop without running out of resources, meaning that energy consumption and economic growth do not need to go hand in hand (GeSI, 2015). According to Demos Helsinki (2015), this is important because the resources are surely not limitless and the dependence must be ended. The correlation of unsustainable resource use and the well-being of people have a defining correlation. The annual population growth is approximately 1.1% (Demos Helsinki, 2015); in 1804 the global population exceeded 1 billion, and in 2016 it has reached 7.4 billion (Worldometers, 2016). The exponential growth can be seen in Figure 4.

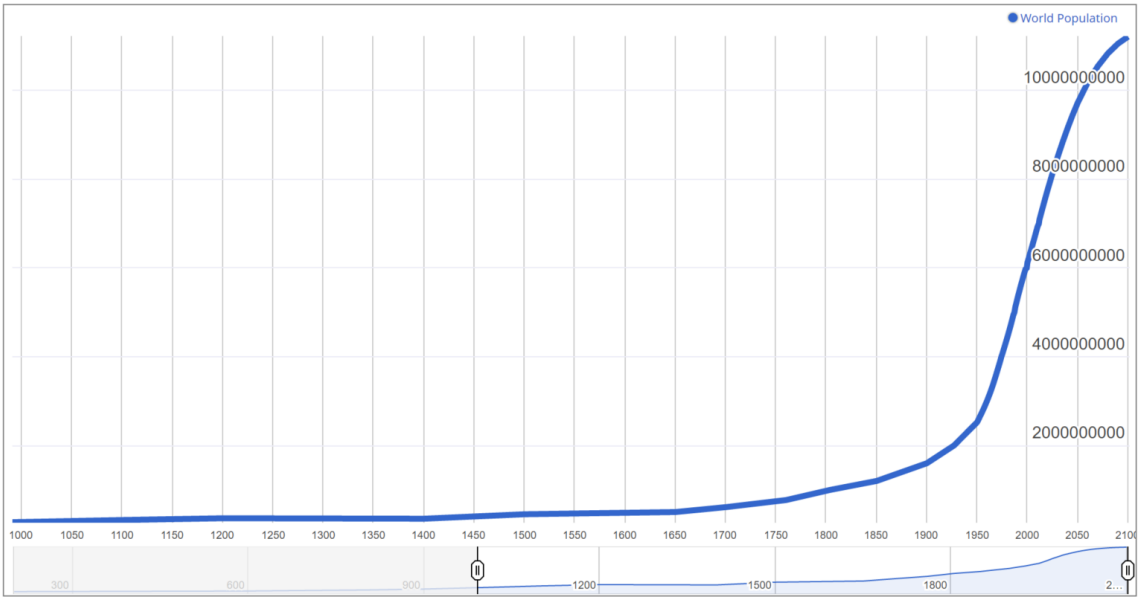


Figure 4, Global World Population growth in 1000–2100 (Worldometers, 2016).

Improving people's lives with technology is also one of the main fields of Nokia's responsibility strategy alongside *Respecting people in everything we do* and *Protecting the environment* (People and Planet 2014, 2015). The last one is *Making change happen together*, which states that co-operation with different organizations and stakeholders is effective and therefore enables greater contribution than acting alone. Also, Riitta Resch, Senior Advisor of Ministry for Foreign Affairs for Finland, has spoken in favor of working together to reach sustainable development targets. According to Resch (2015), it is impossible to reach these targets without global collaboration.

Therefore, it is remarkable, that on September 25th-27th 2015, 193 countries adopted the United Nations' (UN) 17 Sustainable Development Goals (Figure 5) which include 169 sub-targets designed for global use. The agenda is titled *Transforming our world: the 2030 Agenda for Sustainable Development*. Both the goals and targets stimulate action during the next years up until 2030, and all countries and stakeholders will cooperate to reach the goals. (United Nations, 2015a.)

According to the United Nations (2015a), the goals are ambitious and various, and they will stimulate action over the next one and a half decade. According to Rajeev Suri, the goals are important and necessary, but they "will not be achieved unless we are able to harness the power of technology to accelerate the process" (Nokia, 2016c). Connectivity plays very significant role in helping to reach the goals.

It is worth noticing, that according to Accenture (2015), ICT and connectivity are linked to every one of the SDGs to contribute to achieve the wanted results. ICT and connectivity enable many levels that reach for the goals. Accenture's report (2015) outlines ICT's link to the SDGs and it is acknowledged that ICT contributes towards target achievement. ICT, or access to it, has been mentioned in many of the goals explicitly as an enabler for goal achievement.

Also, whether or not ICT has been mentioned, it has a high enabling potential; for example, improving health and preventing climate change. Digital economy keeps accelerating its growth, which enables greater connectivity and new innovative business models. This process will be individual-centric with greater possibilities, and it will be driven by policymakers, business leaders and consumers. (GeSI, 2015.)

Figure 5, United Nations' 17 Sustainable Development Goals (United Nations, 2015b)

Furthermore, according to Demos Helsinki (2015), the Internet was a promise immediately after its creation, since it could help find new solutions for problems regarding all fields of business as well as societal challenges. It is certain that there will be a remarkable increase in accessible information globally, and it neither asks the users' geographical location nor their personal wealth. The information may be used in meaningful ways because of its amount, and therefore even complicated problems may be solved together; people are also more contiguously connected to each other, and the number of both people and devices is increasing.

Demos Helsinki (2015) lists nine technological enablers that could disrupt the world we know in a fundamental way by becoming part of the physical environment, and therefore change the behavior, norms and even values of people. Four of these, *Increase in accessible information; Growth and abundance of computing power; Sensors* and *Energy self-reliance* are recognizable solutions for challenges also identified by Nokia and the UN.

3.2 Economic Impact

3.2.1 Impact on the Economy and Livelihood

Digital economy is growing fast and it has many benefits. Greater connectivity allows there to be up to 100 billion more devices connected to each other by 2030. There is also greater potential for ICT-enabled business models such as Airbnb, the Internet website for listing, finding and renting accommodation, enables registered people's homes to be used as hotels all over the world. (GeSI, 2015.)

ICT also has significant potential to generate economic benefits in many sectors and to prevent people from living under poverty. According to GeSI (2015), eight economic sectors will create the greatest sustainability benefits, made possible by ICT: *mobility and logistics, manufacturing, food, buildings, energy, work and business, health* and *learning*. By the year 2030, it may be possible to generate economic benefit worth $11 trillion in the sectors mentioned.

Smart energy solutions are also vital for economic growth. Fossil fuels are unsustainable and shifting to renewables is necessary in order to stop the climate change caused by man. In addition to the 1.8 Gt CO_{2e} emission reduce and efficiency, Smart Grids and analytic solutions with advanced energy management could generate new revenue opportunities worth $0.8 trillion. (GeSI, 2015.)

ICT solutions have a positive impact on energy reduction and water consumption and they therefore save money. With smart solutions, energy costs for buildings could decrease by $0.4 trillion in the housing sector, in addition to another $0.4 trillion revenue of new opportunities. Furthermore, the savings in decreased food waste and more efficient agriculture could deliver up to $1.9 trillion savings globally and make it possible to feed more people with more efficient food production. (GeSI, 2015.)

Connectivity could also bring clear savings in the housing sector. Smart home installations are expected to generate a $185 billion of revenue for in the energy sector. ICT companies are estimated to gain revenue of $274 billion by providing home connectivity. Potential energy savings in housing sector are $360 billion annually. (GeSI, 2015.)

The competitiveness of European industry may be boosted with circular economy, but it is not possible without digitalization and connectivity; it is therefore important to speed up the development of sensors, meters and cloud services. With circular economy, industries can save materials by using the material multiple time, and decrease their dependence on expensive and non-renewable raw materials. Estimates show that it may be possible to bring added value worth €2.5 billion by 2030 in the fields of machine workshop, forest industry, food industry, construction industry and private consuming. (Sitra, 2015.)

The IoT, in turn, enables industries to monitor the condition of products and components that they have produced, and to upkeep or repair them if necessary. This has a direct effect on employment by creating millions of new jobs. (Sitra, 2015.) According to Pietikäinen (2015), the demand for resources is growing (Figure 6) and Europe's GDP could be increased by nearly one percent by 2030 if the resource efficiency was improved by 30% (European Parliament 2015). This would also bring 1.4–2.8 million jobs to Europe. (Pietikäinen, 2015 & European Parliament, 2015.)

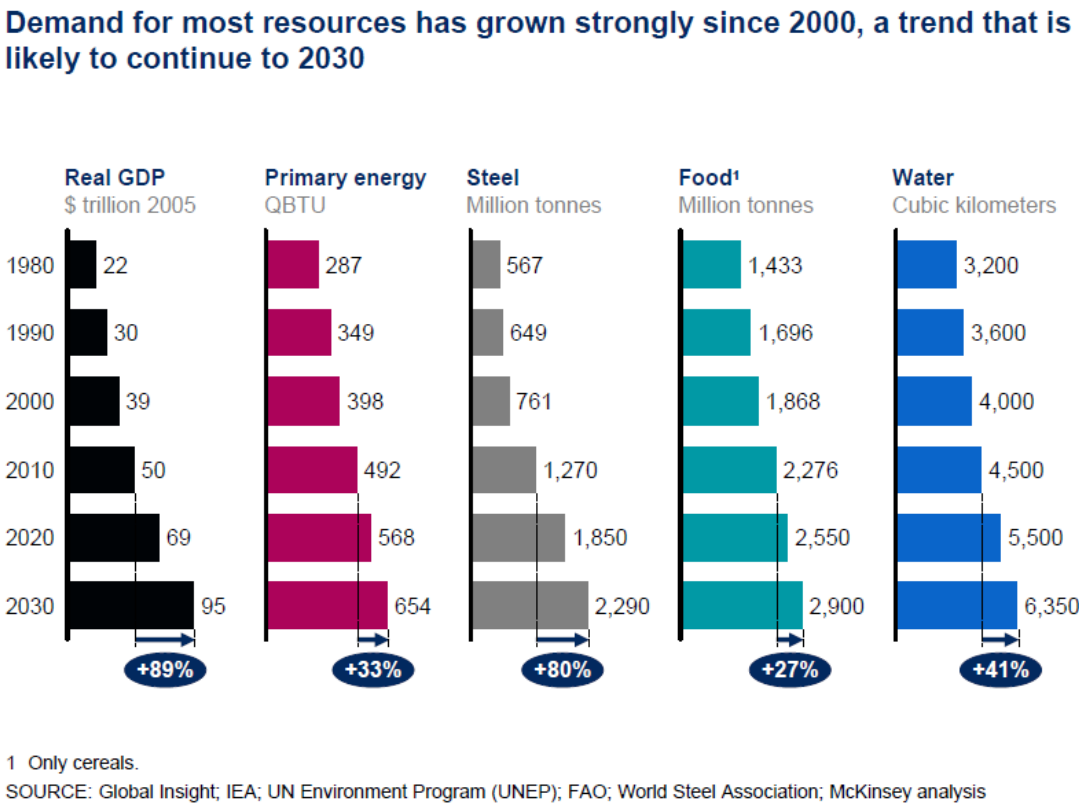


Figure 6, Demand for resources 1980-2030 (McKinsey&Company, 2011).

According to Pohjola (2015), the companies that are able to combine people, digital platforms, effective procedures and global business while answering to the customers' needs will succeed the best. In today's world of digitalization and globalization the driving forces of economic growth are knowledge-intensive service sectors, which use digital technology to reform products and services, information and communication being of them. All this is based on the fast development of ICT.

Today's remarkably low prices allow people to have contact with almost anyone. According to Pesonen (2016), making an international call used to be extremely expensive, and for example in the 1980s, IBM Corporation allowed their employees to have a 5-minute phone call home when they reached the destination country. Nowadays communicating between people is quick, easy and relatively cheap due to improved connectivity and low latency, but earlier the costs needed to be taken into consideration when making a phone call on the other side of the world.

As mobile phones became globally common, data transfer quickly improved alongside with connectivity. It also made it possible to receive information quickly via text messages, and therefore trading, for example, has changed its nature: people are more aware of price levels and supplies. Therefore, competition has increased, especially when prices are easy to find out and the cheapest alternative may be found from the other side of the world (Pesonen, 2016 & Tanskanen, 2015). The resource capital of the knowhow is thus huge, because the whole world's capital is potentially applicable (Tanskanen, 2015).

Digitalization works globally and connects people to each other, which has broadened the possibilities for employees to seek for a job and for employers to find the best experts for the job (Pesonen, 2016 & Tanskanen, 2016). For example, a Swedish advertising agency can hire a talented graphic artist from India to do the job remotely. Connectivity and ICT are also vital for a small entrepreneur, for example, or for founding an e-commerce. Good connectivity is a critical factor in remote areas especially, because without it there are no customers and therefore no livelihood in the business area. (Tanskanen, 2015.)

If there is no need to have the employees under the same roof, there are also no limits to where the employee should be located. (Pesonen, 2016 & Tanskanen, 2015.) Also, teams

are nowadays international, and although it is not always the most optimal situation, it can also be an advantage (Pesonen, 2016). This is one of the ways connectivity has broadened knowhow, since it is possible to use almost anyone's knowledge. (Tanskanen, 2015.)

Telecommuting and virtual conferencing save money as well as time. E-commerce and e-work could add revenues by a total of $2.3 trillion, meanwhile saving the employees' time. (GeSI, 2015.) According to Pesonen (2016), the greatest change in the world lies in the possibilities of data transmission. For example, the car industry has developed a lot, but not a single industry field has developed as fast as ICT; today it is possible for one to be anywhere and contact almost anyone, anytime.

The final revolution has happened through wireless capability. Dealing with things face-to-face may generally be easier, but not having to travel a long way makes it more effortless to communicate virtually or with email or over the phone. Office tools for communicating, such as *Skype*, expand the functionality of a laptop computer, which has basically become an office for an employee. Through Wi-Fi one can work anywhere in the world, if face-to-face contact is not necessary. (Pesonen, 2016.)

There is also new way of doing business. It is already possible to earn a living in many different, untraditional ways. In many cases the Internet, connectivity and ICT are making it happen. For example, a 4-yeard-old cat named Tardar Sauce – better known as the Internet meme celebrity *Grumpy Cat* with her grumpy facial expression – has yielded enough profits for her owner Tabatha Bundesen to quit her job as a waitress. The earnings come from an array of products and commercials the cat appears in. The overall amount is still unknown, since according to Bundesen the suspected $100 million profit is inaccurate. (ABC, 2014 & Washington Post, 2014.) After all, the amount is still remarkably huge.

The first photo of the cat was posted in September 2012, and in May 2013 Grumpy Cat was on the front page of The Wall Street Journal. (The Atlantic, 2012.) This would not have been possible on the same scale without connectivity-enabled Internet, which provides a possibility to rise to world fame within hours, when the target audience is the whole world. If the target audience was defined only to a specific town or state, the word

would not spread as fast as it can with the help of the Internet, where anyone has access to information.

As the case of Grumpy Cat shows, possibilities are limitless in the connected world of today. When earlier having a degree was thought to be a straight road to success, today it depends on many more factors. Internet enables a lot and it also brings equal opportunities to people. For example, with the Internet it is possible to get attention and have fame in both developing and developed countries.

According to Rajala (2016), connectivity has generated great development in developing countries. As an example, in India, the sales and market prices can be checked through a mobile phone application. Also, in developed countries connectivity can be used indirectly to guide the policies in the desired direction. In this case it may be accomplished through a value chain, for example by encouraging investments to certain technology with tax incentives.

In the rural areas of developing countries traditional banking is often impossible, but e-banking has allowed many people to use a bank account for the first time, because with mobile phone it was possible to create one. This allows people to start a savings account and a business, improve their livelihoods and for example education. (Kolehmainen, 2016 & Consumer Technology Association, 2015.) According to Consumer Technology Association (2015), The World Bank has estimated that between 2011 and 2014 the amount of unbanked people dropped by 2 billion people as the amount of mobile phones increased in developing countries (Figure 7).

For example, in Cambodia less than 3.6% of the population has a bank account, but with Wing Mobile, a mobile banking system, an additional 260,000 people were brought to financial inclusion. The majority of these people are among those who make less than $3 a day. (Deloitte, 2014.)

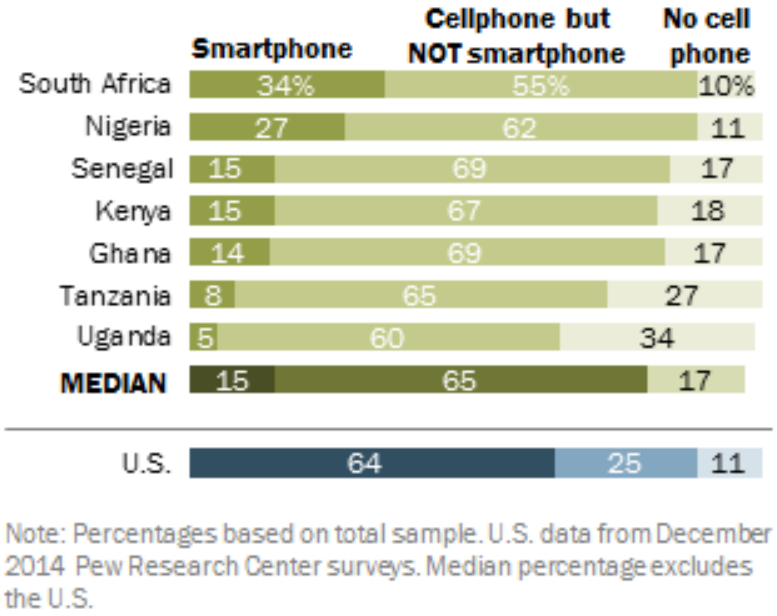


Figure 7, The percentage of owners of a smartphone, cellphones and no phone owners (Consumer Technology Association, 2015).

Microfinancing is also enabled by connectivity. *M-Pesa* is money transferring and financing service for mobile phone platforms, and an important part of Kenya's economic interaction; in 2013 as much as 42% of Kenya's GDP flowed through M-Pesa. It has spread almost all over the country and is popular in other developed countries also. Microfinancing through a mobile phone platform has been beneficial development, because in Kenya access to banking and credits had its risks and it also took time. It has been especially useful to the groups who do not have full access to formal financial services. (Forbes, 2015.)

M-Pesa has reshaped the sectors of banking and telecom, and the financial inclusion has reached almost 20 million people in Kenya, which in turn has enabled thousands of new small businesses to be created. The more users the mobile money market reaches, the more widely accessible it may become. (Forbes, 2015.)

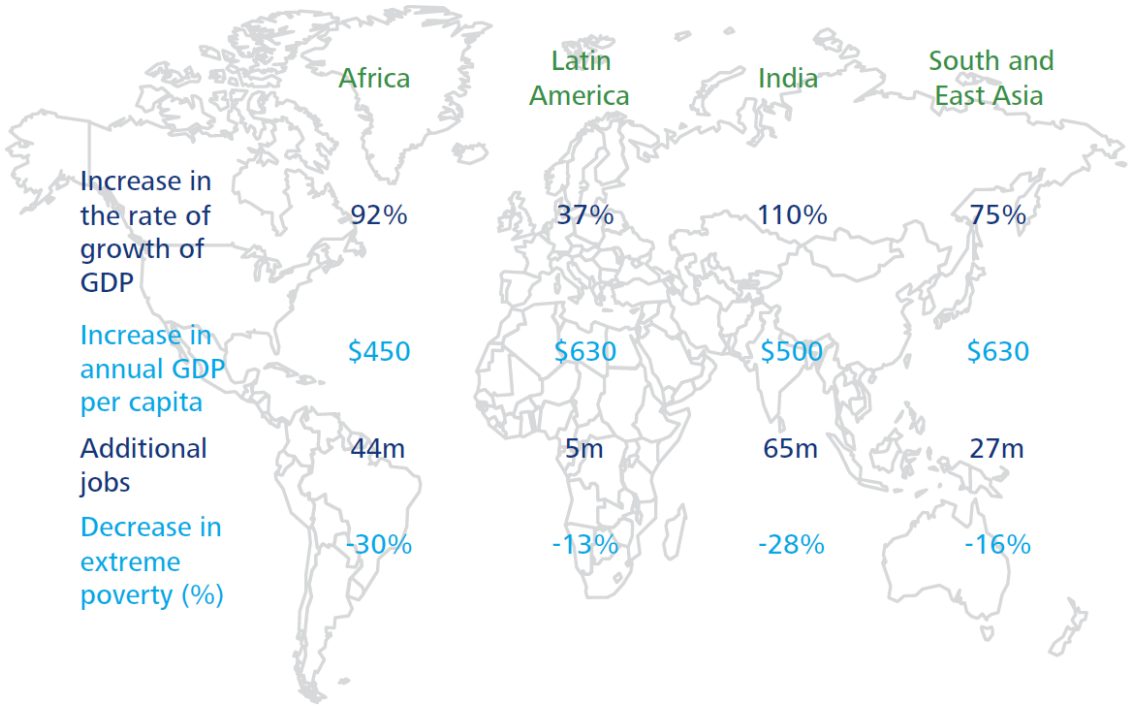
In 2013, India's connectivity score was only 2.14 of 10 in resource and efficiency-driven economy (Connectivity Scorecard, 2013a). It is calculated by *Connectivity Scorecard*, a global ICT index, which ranks countries worldwide to scale from 0 to 10. It takes into account how well countries are able use broadband lines. The aim is to make a link

between connectivity and economic performance. (Connectivity Scorecard, 2014 & Connectivity Scorecard 2013b.)

Still, almost 78% of Indians have basic mobile phone connection at the very least, and smart phone penetration is expected to grow from 13% (in 2014) to 70% by the year 2030. Mobile connectivity and Internet services are making a significant change in the Indian consumer market, which is helping India's sustainable growth. (GeSI, 2015.)

Mobile phones may be remarkable when it comes to accessing financial information. *Nokia Life*, a subscription-based mobile information services suite for a number of Nokia's mobile phones in 18 countries, has provided its users with, for example, financial literacy. The application surpassed the 100 million user global milestone in 2013. (People and Planet 2013, 2014.) Accessing the needed information may help people to maintain their livelihoods.

According to Deloitte (2014), if developing countries were to reach the levels of developed countries in Internet access, meaning a penetration level of approximately 75% of the population on average, an additional 2.2 billion people would be able to access the Internet. Furthermore, in Africa, Latin America, India and South and East Asia it would create 140 million new jobs and lift 160 million people out of extreme poverty (Figure 8), as personal incomes would increase up to $600 per person per year.



Source: IMF, ILO, World Bank and Deloitte analysis

Figure 8, Economic impacts of extending the Internet penetration to the level of 75% in Africa, Latin America, India and South and East Asia to the level of developed countries (Deloitte, 2014).

3.2.1 Efficiency and Productivity

Mobile technology and connectivity are significantly increasing GDP, and Internet access increases the productivity of the economy (Figure 9). According to Ally (2009), many working sectors can increase their productivity and improve the quality of their products by accessing information with the help of wireless mobile technology. Researches show that the addition of 10 mobile phones per 100 inhabitants increases the GDP by 0.6% in emerging markets (People and Planet 2013, 2014 & CPRsouth, 2015).

Furthermore, a number of studies show there's a link between Internet penetration and productivity as well as economic growth. A 10% increase in broadband penetration alone increases the GDP growth by up to 1.3% per capita. Earlier research from Deloitte suggested that switching from 2G technology to 3G technology increased the growth rates by 0.15% annually. (Deloitte, 2014.) Therefore, the possibilities of the new 5G technology are remarkable in economic fields.

Improvements can also be measured through Total Factor Productivity (TFP), which takes into account the efficiency which inputs for example measure of economy with technological dynamism. Deloitte's research shows that a 10% improvement in connectivity may lead to as much as a 4.2% increase of TFP in emerging markets in the long term. There is also evidence that up to 66% of the recent increase in TFP is due to ICT. (Deloitte, 2014.)

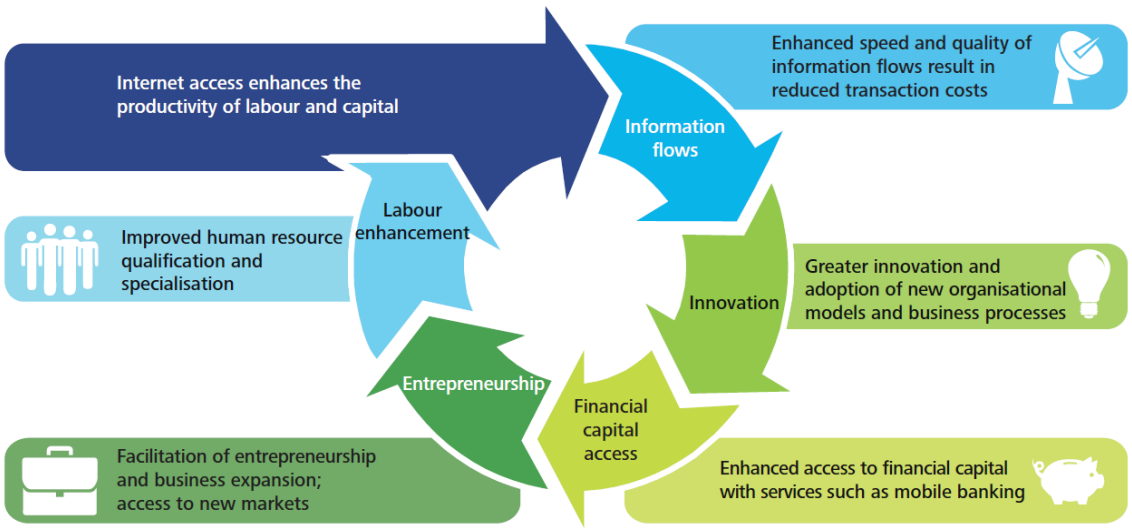


Figure 9, Internet access enhancing the productivity of labor and capital (Deloitte, 2014).

Only 2.7 billion of the world's over 7 billion people have Internet access on a daily basis. Most of the unconnected people live in developing countries. Therefore, it is critical to extend the opportunities of the Internet to make the knowledge-based economy possible. The Internet can accelerate both economic and social growth in developing countries as well as help in the transition from a resource-based economy. Developing countries might have a major increase in GDP growth and productivity, if they were able to reach the same levels of Internet penetration that developed economies have. (Deloitte, 2014.)

It would therefore be possible to reduce poverty and have great improvements in the long term economic and social development. Furthermore, if Africa, Latin America, India and South and East Asia could extend Internet access to the 75% level of developed countries, productivity could increase by 25% in the long run, and it would be possible to generate

$2.2 trillion in additional GDP with the economic activity, in addition to the GDP growth rate increasing by 72% (Figure 8). (Deloitte, 2016.)

Connectivity through ICT can help increase efficiency significantly and at the same time reduce congestion and emissions, as well as resource consumption. The mobility and logistics sector could be much more sustainable, as could the field of personal mobility, and it could be more efficient as well. There will be approximately 2 billion vehicles on the roads by 2030. ICT's impact on logistics is also great, and the IoT may help create a system with which it would be possible to transport products, vehicles and load units safely and efficiently. (GeSI, 2015.)

Traffic controlling and optimization can be supported by ICT. Receiving real-time information of traffic conditions is going to be possible by connectivity between cars, roads, lights and control systems. For drivers this means that it would be possible to drive at an optimal speed and to avoid traffics or to find the nearest parking lot, for example. More information and planning may lead to more efficient driving, routing and parking. (GeSI, 2015.)

3.2.2 Time Saving

According to Houghton (2009), dematerialization can save time and decrease the need to travel due to e-commerce and online shopping. This way there may also be less traffic congestions. Individuals, employers and the whole community can have the benefits of reductions in transport and commuting time due to e-working enabled by ICT.

Also, according to GeSI (2015), telecommuting and virtual conferencing save money as well as time. E-commerce and e-work could add revenues of $2.3 trillion in total by 2030, while saving the employees' time. When working with ICT-enabled applications such as Skype, an employee does not have to travel to be able to join a meeting. Virtual conferencing and telecommuting could save up to 100 hours per e-worker every year by 2030. For an office worker this would mean more than 2.5 weeks annually (when working 37.5 hours per week).

Connectivity and applications enable real-time information regarding transport, while 5G enables latency to be reduced to milliseconds. According to Nokia Technology Vision

2020 (2015), fast connection is almost a “basic right” among people nowadays, but it may also enable autonomous vehicles and self-driving cars, which are highly likely to save time, when the time that is spent driving the car could be used for other activities (Anderson et al., 2014 & Azmat, 2015). Travelling in this manner is safe, affordable and fast and it will be easier to reach the intended destination (GeSI, 2015). Time saving may also have an effect on the commuter’s willingness to travel longer distances between home and work, which is why people might settle down on a wider area than just the urban core (Anderson et al., 2014).

It is also worth mentioning, that Nokia’s OZO, the world’s first professional virtual reality (VR) camera, decreases stitching to minimum, which saves months of processing work, because the device does everything at once by itself (Mehtälä, 2015).

3.3 Social Impact

3.3.1 Digital Inclusion

Connectivity also enables social benefits, but only 2.7 billion of the world’s people have access to the Internet. Most of the billions of unconnected people live in developing countries. Internet access in developing countries provides health, education and social inclusion, and extending it could improve the quality of life remarkably, as the Internet’s connectivity and access to extraordinary amounts of information already generate positive impacts. (Deloitte, 2014.) ICT has been recognized as promoting social inclusion through ICT infrastructure-relied public services and digital inclusion (Figure 10) (Deloitte, 2016).

There is still a huge number of people without the understanding of or access to the devices required. Digital inclusion is about the ability and possibility to use technology, and about the inclusion of people who are digitally excluded through the digital divide (Technology Enhanced Learning, 2011). It is about making sure that everyone, individuals and also disadvantaged groups, have access to ICT and are able to benefit from the information society (Washington State University, 2016) without issues such as lack of opportunities, access, knowledge or skills (Digital Inclusion Survey, 2016a). Moreover, the prices of devices may be a definitive factor when it comes to accessing ICT.

Furthermore, according to Rajala (2016), connectivity has also enabled illiterate people to still be able to use mobile phones. With the help of an application that uses specific pictures, numbers and voice signals, it is possible to signify different things, which makes using a mobile phone easier to those who cannot read.

Moreover, according to Andrews (2016), Nokia has been active in furthering digital inclusion through bringing technology to a wider market for elderly, disabled, visually impaired and illiterate people. Haptic feedback, gesture control, voice control and other hands-free input and output techniques help many people in daily basis. Nokia also has filed many patent applications in these areas.

Bell Labs and Nokia Technologies power the innovation to create and licence the technologies that connect people. (Nokia, 2016e.) They have created approximately 31,000 patent families together (Nokia, 2016e), thousands of which are related to connectivity, and many of them are used in every cellphone in operation worldwide. Nokia's impact, in essence, is that half of the population of the world owns a cellphone. (van Waes, 2016.)

Figure 10, ICT expands social inclusion through public services and digital inclusion (Deloitte, 2014).

Many day-to-day procedures such as work, entertainment and communicating with each other have become digital, and they are more and more reliant on digital technologies. Already at turn of the millennium the U.S. Department of Commerce (2000) stated that

raising the level of digital inclusion is a vitally important national goal, which should be implemented by increasing the number of citizens who use technology tools.

Furthermore, according to Rajala (2016), people are ready to pay for mobile broadband regardless of their wealth. Personal connectivity is regarded an extremely important part of life, which has become a necessity instead of luxury. Even the poor want it, regardless of their minor incomes. Hyperoptic's (2015) survey of 3000 consumers shows that in the United Kingdom residents spend approximately nine hours online daily. According to the survey, 45% of Brits would give up chocolate, 24% alcohol and 22% sex for a week rather than their mobile broadband.

The American magazine *WIRED* and Nokia have a common initiative #*maketechhuman*, including Professor Stephen Hawking in debate and sir Tim Berners Lee, the inventor of World Wide Web (WWW), as a host. #maketechhuman focuses on identifying opportunities created by technology, thus shaping the future in a positive way based on conversation, awareness and content. (Nokia, 2015e.) Connectivity has increased equality exponentially, because through networks people can engage in important matters anywhere. As an example, working from home is possible even though it would otherwise be impossible, and for example pensioners are able to work a few hours a day if they want to (Oksanen, 2015).

Through the affordability of ICT, it is possible to support digital inclusion by enabling people with lower incomes to use networks and access information as well. The more inexpensive connectivity is, the greater the benefits are, because more users can take advantage of useful services and applications. (Kolehmainen, 2016.) Connectivity has basically been a basic human right for all of the people in the world from the first decade of the launch of the mobile communications. It is not a status symbol of few anymore; instead, it connects billions both in developing and developed countries thanks to the mass affordability of GSM and 3G technologies. (Nokia Technology Vision 2020, 2015.)

There are six main pillars in Nokia's technology vision 2020, in the era of 5G (Figure 11). By supporting up to 1000 times more capacity Nokia could answer to the ever-growing need for communications. Instead of expensive and challenging, the usage

should be made affordable and easy for people. Furthermore, mobile networks are, in some developing countries, the only infrastructure that works. (Lukander, 2015.)

By reducing latency to milliseconds and teaching networks to be self-aware, the quality of networks would be better and people could therefore trust the availability of the services more. (Lukander, 2015.) Minimized latency may even have a positive effect on health, since single delays increase heart rate by 38%. In the study the level of stress was comparable to watching a horror movie. (Ericsson, 2016.)

Machine learning and artificial intelligence could also serve people with self-aware networks. Flattening total energy consumption is crucial in order to reduce emissions, but it would also bring savings. Reinventing Telcos for the cloud as well as personalizing network experience applications and personnel services provided by operators would be easier to implement. Networks would be able to provide a good experience with the data it collects of its own work. (Lukander, 2015.) All of these six main pillars of Nokia's technology vision contribute to the lower price per bit (Figure 11). They also bring more people to the scope of the benefits of the networks and connectivity (Kolehmainen, 2015), and therefore help prevent the digital divide.

Figure 11, Nokia Networks Technology Vision 2020 (Nokia Technology Vision 2020, 2015).

3.3.2 Impact on Education and Information

There is incredible potential in improving education, literacy and access to information with the help of connectivity and ICT. According to the report of UNESCO (2014) in cooperation with Nokia and Worldreader, during earlier centuries books were all but the only way to read and not everybody had access to information. Today, reading is possible through mobile technology, which is more inexpensive nowadays than it was earlier. According to Ally (2009), there will even be no choice but to deliver the materials electrically on mobile devices for education and training, as the usage of mobile devices increases.

According to UNESCO (2014), mobile devices and connection to the Internet are extremely potential ways to improve education and the level of literacy (Figure 12), also in the future. According to GeSI's (2015) report, the ICT sector is committed to expanding access so that 2.5 billion people more could be brought to the domain of distance learning and 450 million people to become e-learning participants. This could help raise incomes by 11% per e-degree on average.

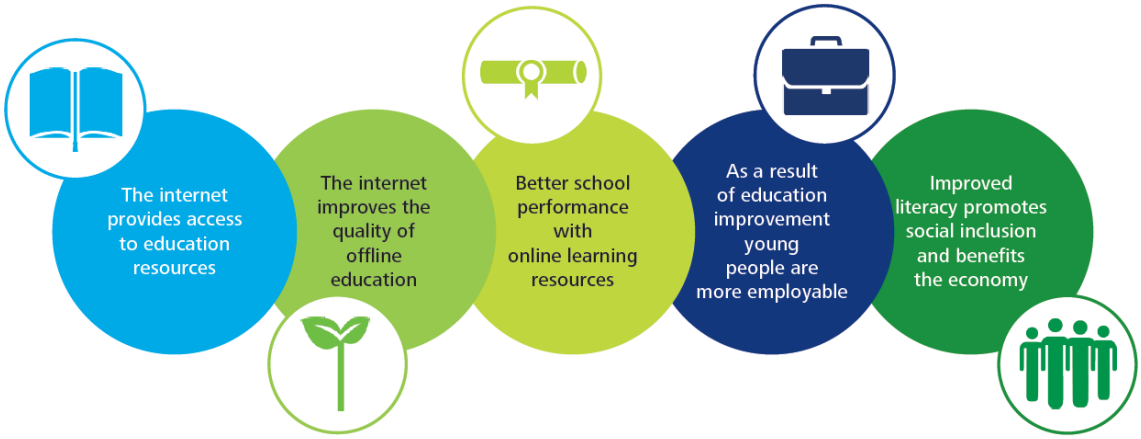


Figure 12, The Internet access' impact on education (Deloitte, 2014).

Education will be more affordable and engaging in the future. Studying will be easier to access and become more flexible. This change allows for example students in the savannahs of Africa to follow and attend a lecture at Harvard University in real time. (Kolehmainen, 2015.)

According to Ally (2009), mobile learning can transform the way education and training are delivered in the world. Through wireless mobile technology people can decide when they want to read and access information. They do not have to wait for a certain time or to be in a specific place to be able to do it. This is also convenient for the educators and trainers, who can plan and deliver their lessons by accessing learning resources anytime and anywhere.

In Africa, for instance, owning a book is unfamiliar to most children, and even the schools may only have one textbook for 10–20 students. This has made it slow for children to learn to read, which also effects learning many other school subjects. Furthermore, a link has been discovered between wealth and access to books almost all over the world. After the possibility to replace books with mobile devices, the potential to improve people's literacy and education has increased; people read more and enjoy it more with mobile devices. (UNESCO, 2014.)

In the United States the libraries also offer more e-books than a few years ago; the percentage increased from 52% to 90% in 6 years between 2008 and 2014 (Digital Inclusion Survey, 2016b). Through this kind of public services people have easier access to information despite their lack of money; according to Ally (2009), the use of wireless, mobile, portable and handheld devices is diversifying and becoming more general across all sectors of education, both in developing and developed countries.

Nokia is willing to use technology to develop education by improving connectivity. The important matter is to grant children access to education. The company is working in co-operation with many NGOs to unleash the human possibilities of technology throughout various projects. Pilot projects, for example, make it possible to have an understanding of the basics of the results and to develop education to work better. The pilot platforms also help obtain the knowledge to develop the system by bringing the best of modern ICT technology into it. (Baijars, 2016.)

Nokia will, for example, participate a project in Myanmar with the aim to develop education with technology. There will be a project to develop the network between schools in order to improve communication, which eases the teachers' work and develops early childhood education. Therefore, the teachers may communicate with each other

more easily. In this manner, societal responsibility and corporate responsibility make an impact on the target's functionality and the general atmosphere. (Baijars, 2016.)

Nokia and Global Giving, and NGO, have a project to give children in rural schools in Ghana solar powered libraries and computer classes (Nokia, 2015d). According to Ally (2009), reaching people in remote locations with wireless mobile technology is a major benefit, because they do not have to leave the geographic location where they are to be able to access instructions and information. Nokia's and Global Giving's project will enable 1,800 children to access ICT and the Internet through a solar powered mobile library van (Nokia, 2015d.)

It is extremely important for e-learning to develop global connectivity in schools and libraries in order to, for example, increase digital literacy (GeSI, 2015). Findings also show that it may be even more significant to have a digital library than a traditional one, which is a great piece of information for governments to have in order to improve the education of developing countries (UNESCO, 2014).

Worldreader Mobile is a free application launched in 2012. It grants access to books with many types of mobile phones. It was launched by Worldreader with the aim to lower the amount of illiteracy in unwealthy countries by providing a large, culturally relevant inexpensive digital library. In 2013, Worldreader Mobile had on average 334,000 users monthly, and is therefore one of the most popular applications for mobile reading, as it can be used with any mobile phone with a data connection. (UNESCO, 2014.)

According to UNESCO (2014), it is also common to use mobile devices to read stories to children, even though young people are more likely to use mobile devices for reading than elderly, who assumably need guidance to use the devices. Convenience of reading was the most important reason to read with a mobile device (Figure 13), while the second reason was its affordability.

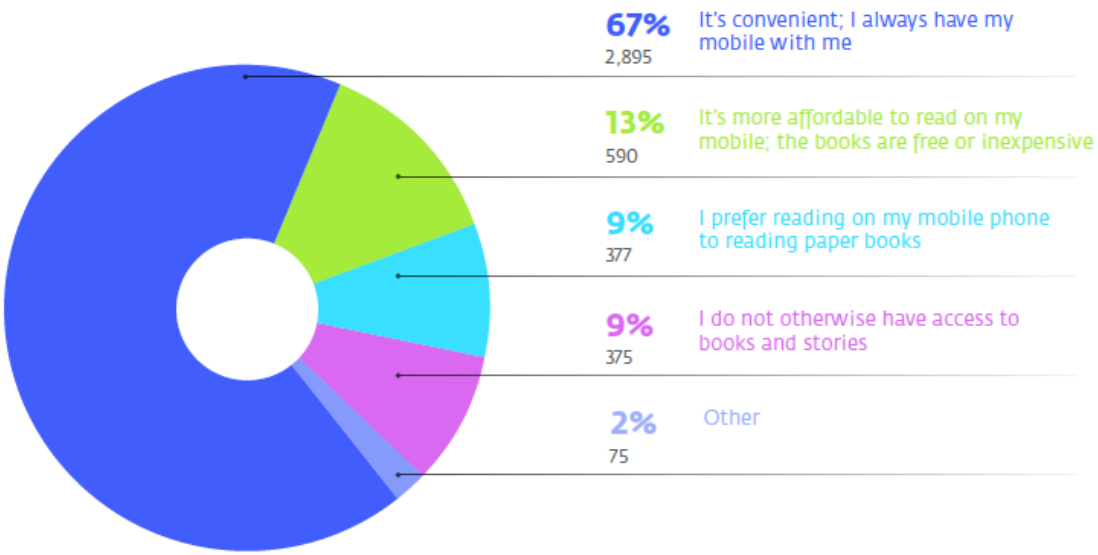


Figure 13, Reasons to use mobile phone for reading in African countries (UNESCO, 2014).

3.3.3 Impact on Health

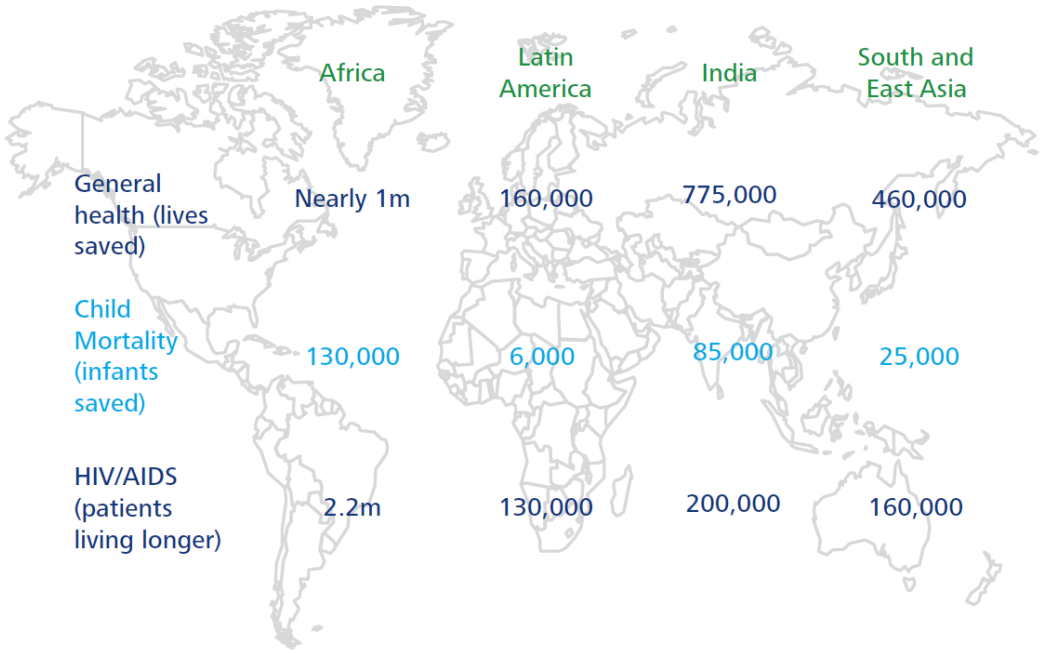
Digital healthcare is a growing trend, and lots of money is invested in it. The Internet provides access to information and may thus improve people's health. Medical information is also available through the Internet, and mobile and Internet technologies can help shape more efficient medical behavior. (Deloitte, 2014.) Patients and doctors do not necessarily even have to see each other, since a connectedness between them is enough in many cases (Vuori, 2015 & Deloitte, 2014). Even basic healthcare information and available services could save a remarkable amount of lives. (Deloitte, 2014.)

In developing countries, common shortcomings include lack of money, specialized personnel and health literature, but with better information it might be possible to reduce the occurrence of different diseases. Mobile applications play an important role in this: Nokia Life has provided its users with information on health, education and, for example, financial literacy. With the application, 100 million users have accessed information regarding e.g. nutrition, hygiene and prevention of common illnesses. (Nokia, 2012.)

Moreover, according to Nokia Sustainability Report 2011 (2012), mobile technology can help people stay healthy and make healthier choices as well as place health information and services within their reach. Mobile technology therefore plays a crucial role in improving human health and wellbeing. Furthermore, Nokia's data gathering software

has helped diminish dengue fever cases in the Amazon: the amount of cases decreased by 93% in 2011.

If Internet access in Africa, Latin America, India and South and East Asia reached the same levels than in developed countries, it could save 2.5 million people (Figure 14), and 250,000 children due to improved health literacy. Furthermore, better monitoring and adherence to treatment could increase the life expectancy of 2.5 million HIV or AIDS patients. (Deloitte, 2016.)



Source: WHO, World Bank, United Nations and Deloitte analysis. The impacts on the different health outcomes are not cumulative.

Figure 14, Health impacts of extending the Internet penetration to the level of 75% in Africa, Latin America, India and South and East Asia (Deloitte, 2014).

According to Lukander (2015), connectivity has improved the possibilities to benefit from medical services in a new way as well because of data transmissions. ICT makes it possible to contact a doctor without being in the same room or even the same continent, and even telesurgeries are possible; the world's first remotely operated surgery was performed already in September 2001, as the surgeons in the United States (U.S.) operated on a patient in France by controlling a surgeon robot. (IST, 2004 &

Tekniikka&Talous, 2014.) This type of telesurgery is possible with reliable high-speed data connections and small latency (IST, 2004 & Tekniikka&Talous, 2014), which 5G will only improve.

Telemedicine enables patients to receive care from the best doctors, regardless of their location. This is especially useful in situations where the hospital lacks knowledge of the operation. Therefore, it is possible to use the expertise of a surgeon without the need to travel across the world. (IST, 2004 & Tekniikka&Talous, 2014.)

Since healthcare concerns every human being, it is a major cost for governments. At the moment the healthcare system is based on after-care, which means that when the patient is sick enough, he/she will go see a doctor, get treatment and take medicine, for example. This is not cost-effective or sustainable for the public economy, because when the patient meets the doctor, welfare diseases such as hypertension and diabetes are already highly developed and therefore need continuous medical care, possibly for the rest of the patient's life. The system should be preventive instead, which could save significant amounts of money and improve quality of life. (Vuori, 2015.)

Connectivity devices have a vital part in making this change by helping people maintain their health and prevent future diseases. Maintaining and preventing are done by patients themselves, thus diminishing the need to physically see the doctor, even if the patient is ill (Figure 15). (Vuori, 2015.) On special health spots in pharmacies people can measure blood pressure and fever without going to see a doctor. These devices are commonly used, which is useful especially if they are too expensive to buy home. (Harju, 2015.) This way circular and sharing economy can be used also to help to maintain people's health.

According to Vänskä (2016), healthcare costs are globally increasing faster than the GDP, and in the United States over 80% of the costs are related to chronic diseases (Goldman Sachs, 2015). Approximately 50% of adults have a chronic condition (National Health Council, 2014). In the U.S. the annual cost of chronic disease management is $1.1 trillion, and these chronic conditions account for a growing part of the costs (Goldman Sachs, 2015). The complexity lies with the patients suffering from e.g. diabetes and heart diseases. These patients are not in hospitals but at home, and continuously in touch with doctor. The more aware the doctor is about how the patient is doing, the easier it becomes

to help them. The problem is that at the moment doctors only receive ”snapshot information” of the patients, meaning that the information is not ongoing and refined, but momentary instead. (Vänskä, 2016).

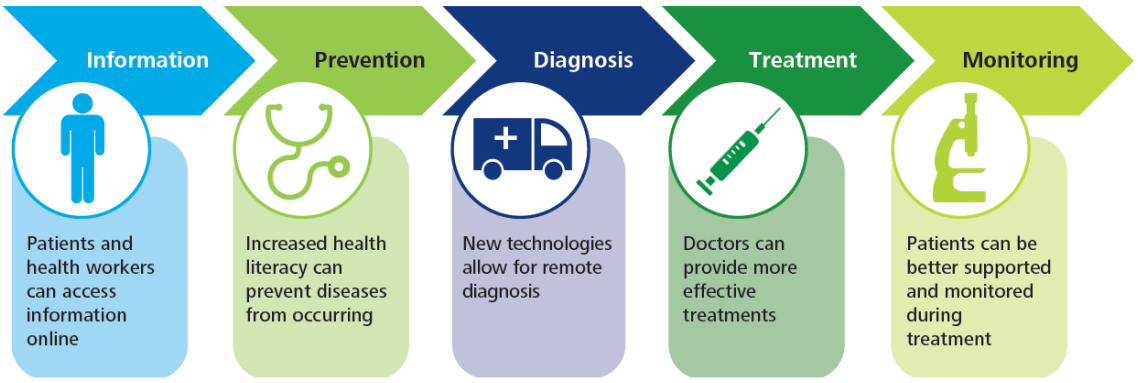


Figure 15, The impact of the Internet on health (Deloitte, 2014).

According to Goldman Sachs (2015), digital healthcare may revolutionize the healthcare industry, and large healthcare companies have already started adopting it. The costs it creates would only amount to a fraction of the current costs, and digital healthcare would allow extensive access to making a diagnosis, receiving treatment and preventing the illness altogether (Figure 16).

Healthcare IoT could improve the care that is given to patients as well as lower the costs and reduce waste. The IoT could divide the market into remote patient monitoring (RPM), telehealth and behavior modification. Throughout digital health technologies, the financial opportunity in systems savings could potentially be over $300 billion. (Goldman Sachs, 2015.)

Furthermore, the IoT is able to unleash healthcare’s disruption power (Goldman Sachs, 2015). With connectivity it is possible to receive continuous information of patients in their homes with wireless sensors, and then transfer the information to the cloud and convert and present it in a relevant format to help the patient in the best possible way, while cutting costs significantly. (Vänskä, 2016.)

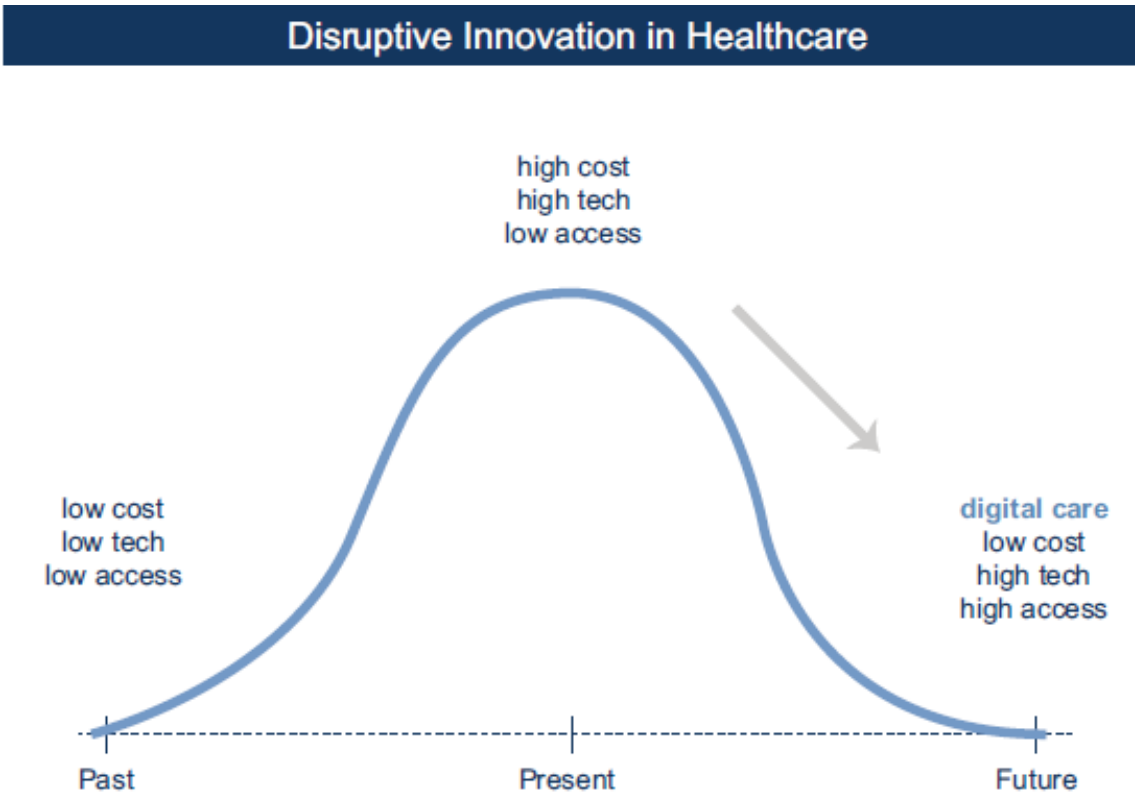


Figure 16, Digital healthcare has the potential to be easily accessible with low cost (Goldman Sachs, 2015).

Also, in Finland, if the Healthcare, Social Welfare and Regional Government Reform Package (in Finnish: Sote- ja aluehallintouudistus) will come to force, it will bring greater responsibility to university hospitals, since they have to take care of a larger population. Wireless technologies and the monitoring of biosignals are essential in solving the issue of offering healthcare to a large population. They may also be used when creating a virtual hospital or clinic. The patients who suffer from chronic diseases can be anywhere but still have a continuous remote relationship with their attending doctor. (Vänskä, 2016.)

This would enable healthcare to be more continuous and therefore better, and it would also decrease medical costs significantly. Earlier medical reimbursements have been based on procedures ("fee for service"), which has led to unnecessary and duplicate tests. In the future, the reimbursements will be based on results, useless procedures will be avoided and the costs will be lower: this is possible by implementing RPM and tracking the patient instead of them having to make frequent visits to the hospital to see the doctor. (Vänskä, 2016.)

Due to connectivity it will therefore be possible to do more in real-time. According to Harju (2015), a patient at risk of a heart attack could have a device that measures his/her EKG (electrocardiogram). If the patient had a heart attack, the device could locate the patient and call for help immediately. The doctor could also receive data of the patient right away even from when the heart attack had not yet started, which might help discover the reason for the attack.

These technologies exist already today. Key barriers to their adoption are legislation, regulation and questions about accountability: if technology companies or medical service providers were to offer such solutions, they might need to assume more accountability for patients than they do today, and it is unclear who would pay for such a service. (Harju, 2015.)

Outcome-based reimbursement system again aims at improving the quality of care. For example, if the patient in the U.S. has been treated in a hospital because of heart symptoms, there is a financial penalty if he/she is readmitted to the hospital within the following 30 days. There is, that is to say, a 30-day waiting period. If the patient ends up in hospital again during this period, the hospital does not receive the best possible financial reimbursement for taking care of the patient. (Vänskä, 2016.)

Furthermore, it is believed that with wireless monitoring sensors and connected machine intelligence, patients could be sent home sooner after an operation or an emergency. Sensors, coaching and reminders delivered through mobile applications could improve adherence to medical treatment plans, while sensors and mobile symptom questionnaires could be used to detect or even predict complications outside of hospital environments. (Harju, 2015.)

In some cases, going to visit a doctor might even be dangerous in itself, for example in rural areas, where there is a chance of being robbed or killed during the journey to the hospital (Vuori, 2015). There is also a possibility that a long journey has an impact to patient's condition, and for example traffic accidents are possible (Kolehmainen, 2016). The distances may be very long, so the risk of leaving might be bigger than not seeing the doctor at all. With connectivity the patient's life may be saved, because the dangerous

trip is possible to avoid by meeting with the doctor remotely. Connections improve and save people's lives in many different ways. (Vuori, 2015.)

Earlier it was hard to have access to one's own medical data, which made it challenging to get or buy the best medical services, and patients therefore ended up using the same services they had used the last time they visited a doctor (Vänskä, 2016). Today it is possible to have access to your medical history and data, and the system is therefore more exposed to competition than before. Competition drives the providers of medical services to invent new ways to meet the patient, which is where remote healthcare steps in as an important part of the solutions. (Vänskä, 2016.) The costs may also decrease and the quality of medicine may improve, which is an improvement for consumers (Kolehmainen, 2016). According to Harju (2015), consumer centricity will increase due to digital healthcare.

As already discussed, chronical diseases are a major issue and preventing them would bring huge savings. According to Vänskä (2016) it is important to help people prevent those diseases themselves, for example by providing relevant measured data and teaching patients so that they have a deeper understanding of healthcare. In this case it is not about illness, but rather maintaining health and helping healthy people to remain that way. The collected biodata may be downloaded to the Internet and it may be refined to an understandable form so that doctors could be able to see how the patient was doing even before he/she became a patient.

People already know that it is important to exercise and not to eat too much sugar, but changing people's behavior with the data is the main point, and in it connectivity is the key. It could help to fine-tune the patient's medication or to advise the patient on how to change their way of life into a healthier direction. (Vänskä, 2016.)

Different applications and wireless devices can encourage to make a change of lifestyle if one is needed, and through the cloud it is possible to have peer support when making that change. Wearable technology encourages people to exercise and it makes monitoring easier. All the information that is received can be transferred into the cloud right away. (Vänskä, 2016.)

By combining traditional and digital gameplay, the users are encouraged to physical activity while interacting socially with other players (Soute et al., 2009). As an example, the GPS-based (Global Positioning System) Sports Tracker application tracks training and measures the user's route, time and speed, etc. It was originally released in 2004 by Nokia, and it is widely used to analyze and enhance training, and to encourage people to exercise. The workouts can be shared with pictures to friends via *Facebook* and *Twitter*. The award-winning application has millions of downloads and it aims to make training more fun as well as help the users to train better and live healthier lives. (Sports Tracker, 2016.)

It is important to bring wireless technology to where it is needed the most in order to avoid the gaps between those who are already doing well and those who are in worse shape. (Vänskä, 2016.) Many applications and games in addition to Sports Tracker encourage people to do sports, for example by having players remotely compete with each other in different physical activities (Soute et al., 2009).

The mobile device application named *Zombies, Run!* for example encourages a walker, jogger or runner to speed up, when in the middle of listening to music through headphones the user hears the zombies unexpectedly attack. The application also allows users to track their runs and share their progress. (Zombies, Run!, 2016.) The purpose of this is to motivate people to be active and to exercise, and gaming in an entertainmental manner is one incentive for users to do so. (Soute et al., 2009.)

Connectivity and ICT may be used in various other ways as well in order to prevent illness and improve the patients' lives. According to WHO (2014), air pollution causes 7 million premature deaths every year, and reducing the emissions would save millions of lives and prevent people from suffering from strokes, ischemic heart disease and cancer. With improved resource efficiency it is possible to decrease CO_2 emissions by 20%, which would also bring €52 billion savings annually in only medical costs (Pietikäinen, 2015).

Mobile devices can also be used as an aiding tool for communication. Some people need augmentative alternative communication (AAC) methods to support speech or instead of speaking, and due to the fast development of mobile technology, communication tools have changed immensely during last decades. For example, tablet computers have

become general communicating tools because of their relatively inexpensive prices and the accessibility they provide. (Mäkelä, 2015.)

Nokia has patents regarding accessibility, such as the patent filed already in 1998, which aims to facilitate usage for physically-disabled users with certain user interface methods (Patent No.: US 64473170, 2002). Due to digital inclusion, no one should be left outside the ICT.

Virtual Reality, on the other hand, can be used to relieve stress on patients who have to stay in hospital. As the illness may force the patient to stay in bed or in a single room or, for example, in a wheelchair, VR technology provides experiences he/she would not be able to have. According to researches, VR could have several uses. For example, it could be used to treat depression or to help pregnant women during long labours. (Huffington Post, 2016.) Furthermore, it may help amputees remove phantom pain and treat children with autism by fine-tuning their motor-skills and train social skills (HuffPost Tech, 2014).

3.3.4 Impact on Safety and Security

When it comes to safety and security, there are many ways to improve lives. The scale reaches from finding lost items easily to saving lives with the help of connectivity. With new innovations as well as more traditional ICT solutions it is possible to, for instance, reach people in disaster areas, increase safety at work and make it safer and faster to drive a car.

Connectivity and remote work provide huge potential for safer work. For example, working with dangerous chemicals or explosives is nowadays possible without having to go near the object at all. Through remote-controlled machines and robots, the work can be done from a safe place without being exposed to the danger. In case of an accident, human life and health is saved and only the robot or machine is damaged. (Rehn, 2015.)

Without connectivity there would be no actions regarding conflict minerals, which are minerals that are mined in the middle of armed conflict or human right abuses conditions. Today, corporate cooperation and monitoring is possible, since the identification of risks and the development of solutions are enabled by connectivity. (Kolehmainen, 2016.)

Connectivity also makes it easier to collect data related to harmful substances (Rehn, 2015).

Automotive industry executives recognize that connectivity and digitalization are the leading trends to have an impact on their business up to the year 2025; the relevance of self-driving cars is increasing, the industry has a major transformation coming up and it needs to continuously adapt to the remarkable changes (KPMG, 2016). Autonomous vehicles (AV) technology will presumably change the nature of transportation. Cars already have driver assistance systems, and they will gradually evolve from level 0 to level 4 (Figure 17) and reach the point of self-driving cars, as suggested by the National Highway Traffic Safety Administration (NHTSA) of the United States (Anderson et al., 2014 & Azmat, 2015). Driverless cars will use video camera, lidar, position estimator and distance sensors (Azmat, 2015), and they require a fast network with ultra-low latency (Pesonen, 2016), which 5G provides.

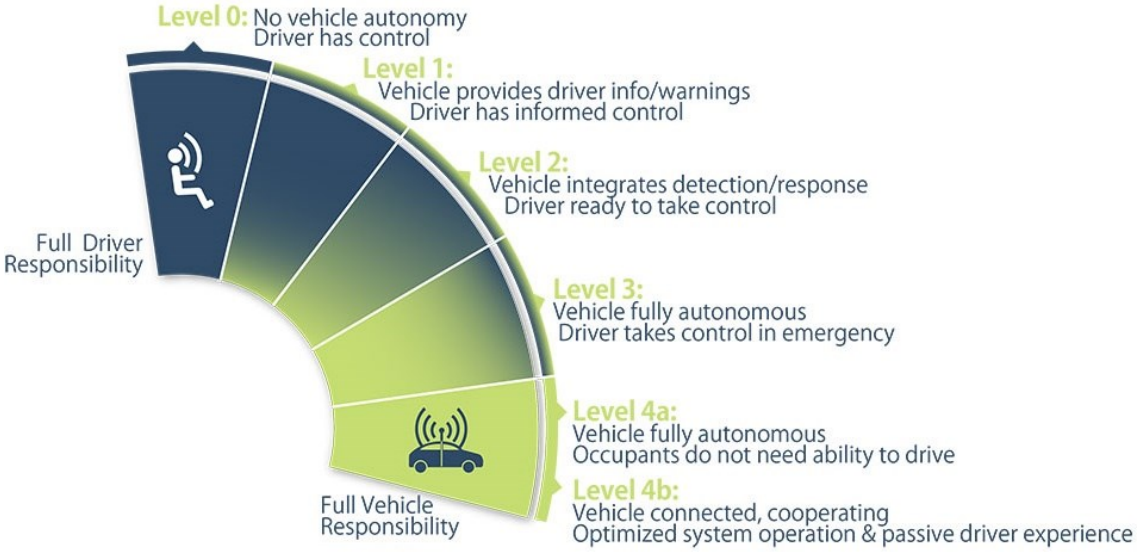


Figure 17, Levels of automation (NHTSA), (Azmat, 2015).

AV and self-driving cars could increase passenger safety by reducing crashes (Anderson et al., 2014, & Azmat, 2015). This is due to improved logistics and mobility in the future (GeSI, 2015). In 2014, there were more than 32 000 fatal motor vehicle accidents in the United States alone (NHTSA, 2015). According to Nokia Networks (2015b),

approximately 1.3 million people worldwide die every year in road accidents, and 90% of all car crashes occur because of the driver's error.

More than 500,000 lives could be saved annually, if the AV and self-driving cars reduced fatalities that involve a car by approximately 50% (Figure 18). If cars communicated with each other, they could automatically brake if there was a car crash nearby ahead. With the same principle they could optimize the route and drive along a route with less traffic. (Nokia Networks, 2015b.)

With optimized driving the costs of congestion could also be cut. When a person drives a car, congestions are likely to increase with every additional conventional driver, which in turn increases the possibility of car crashes. With AV technology, driver could make use the time he/she spends in the driver's seat and do something else, which could lead to people living further away from the city, because instead of focusing on driving, it would be possible to engage in useful activities while sitting in the car. (Anderson et al., 2014.)

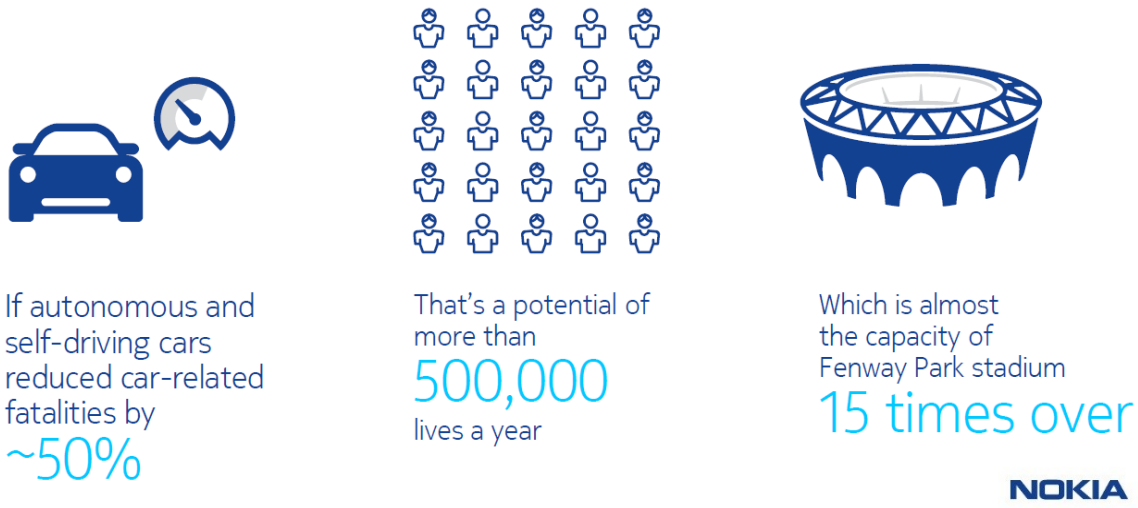


Figure 18, The potential of lives saved by AV and self-driving cars (Nokia Networks, 2015b).

Some car manufacturers, for example Volvo, have introduced a feature that lets the owner control the car remotely with a smartphone (Volvo, 2016) like many other security devices such as antitheft or fire alarm system. In Volvos this feature is designed to ease

everyday life and to help in case of emergency. The owner is informed if there is an unexpected entry into the car, and if the car is stolen, it can be tracked with its own GPS. It can also be immobilized if needed. In case of collision, the car automatically alerts an operator trained for emergency situations, and the operator can then call for help if necessary. (Volvo, 2016.)

Finding lost items such as keys has been simplified, since there are many connectivity-enabled devices and applications to help localize them. In the case of keys, a simple key fob or tag alerts the seeker by emitting a loud noise. This sound alarm can also be used to remind the user to take the keys or wallet with him/her. If needed, the tag can sound the alarm when separated too far from the owner's phone. (Techlicious, 2015.)

A Bluetooth-enabled tag on the other hand shows its own location via an application that helps the seeker find the item. Also, when the seeker is out of range, the item finder utilizes other users' phones that have the same application to search for the tag. When the lost item is localized, the application informs the owner of the location without revealing the seekers information to the phone that is near the lost item. (Techlicious, 2015.)

Locating missing people is nowadays possible with the help of their cellphones by a positioning system and a signal that can be located to the nearest base station. Furthermore, in Finland there is an application especially for emergency situations. It locates the caller automatically during the emergency phone call. The application *112 Suomi* works similarly to an ordinary phone call to the emergency telephone number, but when the call is placed through the application, the public-safety answering point receives the exact coordinates via satellite in WGS84-format. (112 Hätäkeskuslaitos, 2016.)

This is remarkably useful in situations where the caller is not sure where he/she is, for example in a forest or after a car accident on a highway. The application was developed by Digia in cooperation with the Finnish Emergency Response Centre Administration, and the latter recommends to download it to smartphones and teach children and elderly people to use it. The location is used only when the user allows it, but it can potentially save lives. (112 Hätäkeskuslaitos, 2016.)

Nokia supports Save the Children, an NGO, in India with technologies striving to protect children and communities during disasters. The aim is to mitigate the impact of disasters by assessing communities' vulnerability (physical, social, medical, economic, cultural), by building capabilities and by introducing technological innovations. (Nokia, 2015c.) Reducing the disaster risk that impacts children is done by improving their resilience as well as their communities' resilience with the help of Disaster Risk Reduction (DRR). (Nokia, 2014 & Nokia 2015d.)

The help also includes providing better communications and connectivity with latter's telecom and mapping and navigation technologies. In India 176 villages or urban locations are being equipped with ICT platforms; computer hardware and software facilitate villages' DRR planning, for instance (Nokia, 2014 & Nokia 2015d). DRR and communications technologies help protect children for example by enabling them to access the right information at the right time and by providing alternate routes and safe zones (Nokia, 2014). The project touches 350,000 lives together, including 185,000 children. DRR is said to be a step towards directing the efforts of disaster management to saving livelihoods in addition to saving children's lives. (Nokia, 2015c.)

In Nepal mobile phones have been considered among the most effective communication strategies during earthquakes. Mobile phones make it easy to receive information quickly, whereas listening to radio or watching news takes time. Connectivity eases spreading the information of disasters, and it is enough if one or two people get information, because it is possible to convey it to the rest of the community. (Save the Children, 2016.)

3.3.5 Political and Cultural Impacts

Connectivity-enabled social media has had its impact on various political and cultural chains of events. Connectivity can help people to get and share information and it plays an important role in political and societal development. For example, Facebook, Twitter and YouTube have been used to pressure governments and conducted political conversations and changes. (Howard et al., 2011.)

Furthermore, according to Pesonen (2016), social media has also been included in the ongoing European migrant crisis. Information and instructions for migrants have been

available through their mobile phones, and the masses have even been guided and controlled via social media, wirelessly.

According to Seppälä (2011), English plays an important role in China when it comes to having access to information with another language than Chinese. It has opened a new world of information, both inside and outside of China. Also, according to Nunan (2003), English is the unquestioned language of both science and technology, and scientific journals are written in English instead of other countries native languages. As a global language, English has a remarkable impact on policies and practices in every country surveyed in the Asian-Pacific region.

Furthermore, according to Thierry Siminger, President of the French wireless networks company SIGFOX Middle East and Africa (MEA), implementing the benefits of the IoT for applications is a very strong point of interest; for example, connecting the MEA countries to a global network with low-energy-use connectivity (Business Wire, 2015). A wide information society is a benefit for people, and the larger the population to whom the information is available, the bigger the impact is. Constant access to information through the Internet offers the same content to everybody regardless of culture and physical location (Kolehmainen, 2016).

3.3.6 Impact on Human Rights and Freedom of Expression

According to Pesonen (2016), wireless network is the greatest factor regarding human rights. When people have access to the Internet, they can access knowledge and will not be scammed so easily, even in rural areas. In addition to freedom of expression, there is also freedom of information. Already in 1994, Bangemann Report stated that "The information society has the potential to improve the quality of life of Europe's citizens, the efficiency of our social and economic organization and to reinforce cohesion". (Borgman, 2000.)

In today's world it is faster and more efficient to seek information, since people are no longer reliant on libraries: the Internet offers information and knowledge from all over the world in many languages at all times. With legal, economic and policy issues, it is possible to have an effect on how well the Internet scales to the system of global information infrastructure. (Borgman, 2000.)

According to Baijars (2016), access to information increases people's knowledge of what is allowed and what is not, regarding also their own fundamental rights. For example, many child marriages and child labours could be prevented, if people had knowledge of legislation and could claim rights to themselves.

In Uganda, the legislation that regards homosexuality have become very strict during the last few years. The maximum penalty for homosexuality used to be death penalty, but it has been lowered to lifelong imprisonment because of pressure from the rest of the world. (CNN, 2014). Connectivity is in a key position in ensuring the fulfillment of fundamental human rights, such as freedom of expression, while also providing real-time channels to report potential violations of these rights to the outside world (Okkonen, 2015).

3.3.7 Comfort and Amenity Factors

Connectivity and networks are increasing quality of life by offering different comfort factors and luxury goods as well. Technology is used in many ways to increase amenity, which has been normalized as a basic part of everyday life. For example, it is very common to wirelessly check the following day's weather from a weather application and to prepare for it. Communicating is easier and more inexpensive with mobile phones, and it has become part of our everyday life.

According to Church & de Oliveira (2013), after it was created, Short Message Service (SMS) revolutionized the way people communicate. In 2012 there were almost 7.8 trillion SMS messages sent worldwide, which makes it the record year of all time (eMarketer, 2015). During the last couple of years, new Mobile Instant Messaging (MIM) and over-the-top (OTT) mobile messaging service applications have increased their popularity alongside smart phones. The amount of OTT mobile messages is expected to reach 67 trillion by 2018. (eMarketer, 2015.)

For example, the *WhatsApp* application uses the Internet to send messages, images, videos and audio media messages for both individuals and groups. Like similar applications *Viber* and *Line*, it is free to use if the user has Internet connection on his/her mobile phone. These are also some of the reasons why these types of applications will presumably keep growing in the future as the traditional SMS messaging will decrease. Church & de Oliveira, 2013.) Sharing different kinds of content has become part of

people's everyday lives, and the easiness of these types of applications is part of their popularity.

Living in another country as an exchange student or a relocated employee may be easier than before when it comes to communicating with family and friends. Before mobile phones and video chat applications like Skype, the only way to communicate with family during, for example, an exchange year was letters. Nowadays many students write their own blog about their experiences and news, and communicate daily with their friends and family via WhatsApp or other applications. Thanks to free Wi-Fi, it is possible to place free calls through many applications. This is a great improvement from Pesonen's (2016) example of a five-minute international call for the employee allowed by the employer after arriving to the final destination of a business trip.

Internet makes it easier to study, search for information and do research: there is no need to go to the library anymore, because everything can be done by computer. The search engine *Google* and other search portals provide amazing amounts of information and research papers from all over the world, which means that the selection is more comprehensive. Even if the information is provided through a search portal by a certain university, such as the Finnish Aalto University and the University of Helsinki, with a student account it can be accessed remotely (Nelli-portaali, 2016). In addition to finding the required information quickly, lots of time is also saved when the time that used to be spent travelling to a library can be used for efficient work.

Nowadays many games combine traditional playing cards and an application together seamlessly for entertainment purposes. For example, a party card game called *Ultimate Werewolf* by Bézier Games requires at least one player to download a free application to a mobile device. The application replaces a game leader by narrating the selected information and eases the playing by offering an automatic timer and warnings when time is ending, so that the players can focus on playing. (Bézier Games, 2016.) The application automatizes the gameplay, and erases the possibility of human error during the narration.

3.4 Environmental Impact

3.4.1 Impact on the Climate and Environment

The Internet and ICT may help solve many environmental challenges like climate change and waste management issues. ICT has had a remarkable impact on the industrial structure of today's knowledge-based economy with relatively declined manufacturing and increased amount of services, which are also less energy intensive and less polluting than before. ICT has also had a great influence in the globalization of information technology and in making services tradeable. (Houghton, 2009.)

Nokia has recognized that its greatest contribution to preventing climate change is using its proficiency to support build a low carbon economy that reaches beyond the ICT sector. Nokia is an expert in efficient management of complex networks, and therefore has great potential to reduce energy consumption and greenhouse gas emissions. (Nokia Networks, 2016b.) The IoT and the Programmable World (Figure 19) play an important role here and they may help increase positive impact by applications in the environmental area as well (Nokia Networks, 2016a). Furthermore, according to Oksanen (2015), connectivity and technology are needed to solve environmental challenges of vulnerable societies.

The IoT will cover for example homes, cities and energy. The IoT enables to sense and control objects remotely through the network infrastructure, and it will. Throughout the IoT it is possible to move beyond connecting people and things to the Programmable World. Fluent and seamless connection between people and devices drive the opportunity to help solve environmental degradation. (Nokia, 2015f). This way there is a great impact on the environment by helping to decrease emissions and by increasing efficiency in many other sectors than in ICT itself (Nokia Networks, 2015d).

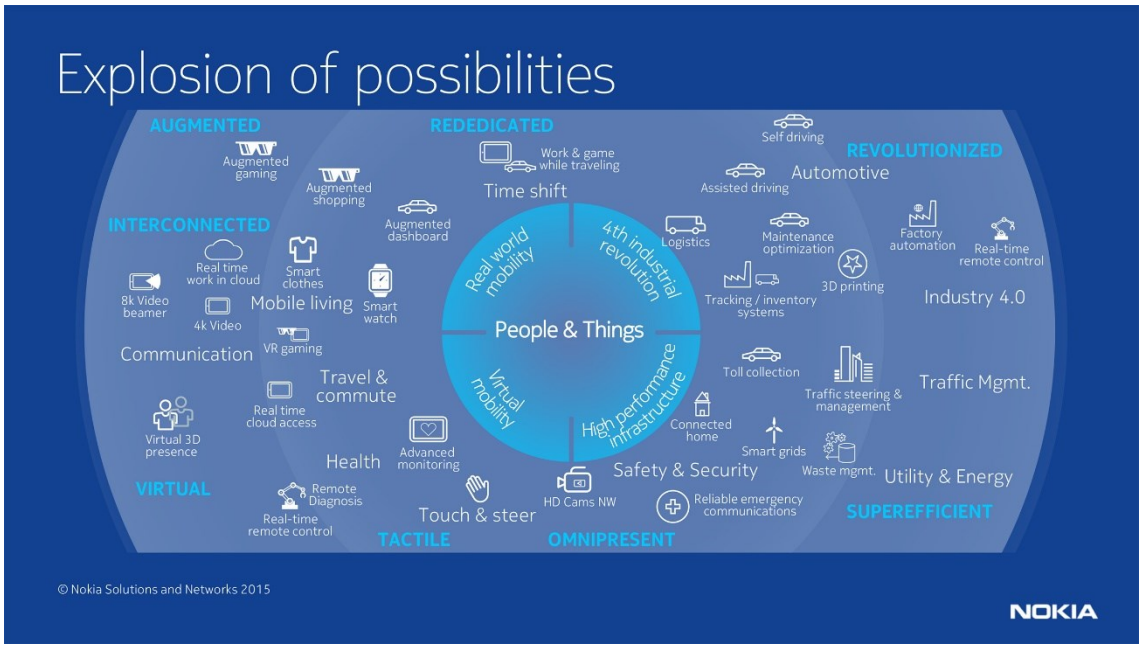


Figure 19, Value chains of the IoT and the Programmable World (Nokia, 2015f).

According to Ericsson (2016), reaching SDG 13, combating climate change, will require both existing and new innovative technological solutions. According to GeSI (2015), ICT may potentially reduce up to 20% of global CO_2 emissions by the year 2030 and separate economic growth from increasing emissions. Making a significant reduction is extremely important, because according to the Intergovernmental Panel on Climate Change (IPCC) (GeSI, 2015), with the current trend the global temperature would rise more than only 2^0C; even 4.8^0C, if the scenario called *business as usual* proceeds. The IPCC states that the global climate emissions must be turned to a decreasing direction in order to prevent the possible climate change catastrophe (Demos Helsinki, 2015).

Due to the historical trend, when GDP increases by 1%, the CO_2 emissions rise by approximately 0.5% and the resource intensity by 0.4%. This vicious circle may be broken with ICT and connectivity solutions. ICT can help other industries decrease emissions with smart solutions (Figure 20). ICT solutions could save 12.1 Gt of CO_2 emissions by 2030 (Figure 21) in the fields of mobility, manufacturing, agriculture, building and energy. These combined have almost ten times the amount of ICT's own estimated 1.25 Gt CO_2 footprint in 2030. (GeSI, 2015.) The current estimate of ICT's footprint has decreased from the earlier estimates as technologies have developed (GeSI, 2015), and will hopefully continue to do so in the future.

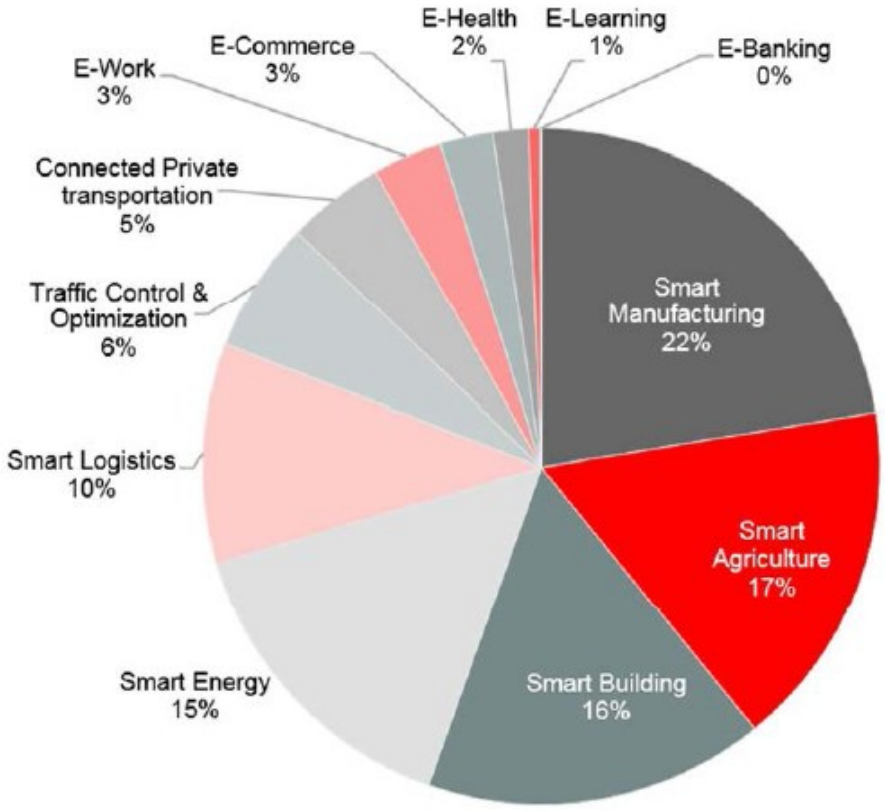


Figure 20, Potential CO_{2e} abatement in every sector by use case (GeSI, 2015).

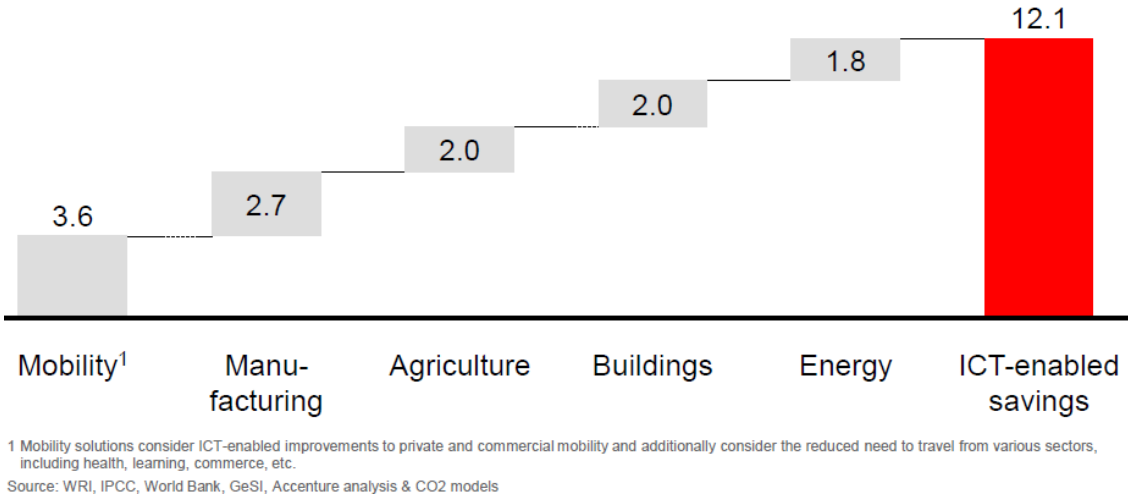


Figure 21, The potential to abate CO_{2e} emissions in different sectors by 2030 (GeSI, 2015).

According to Nokia Networks (2015b), the estimates suggested by the EU show that approximately 12% of all CO_2 emissions in the EU are produced by cars. Autonomous vehicles and self-driving cars could help reduce energy consumption and pollution by 0.3 Gt CO_2 (Anderson et al., 2014 & Nokia Networks, 2015b). Real-time traffic information and other smart e-solutions could help decrease CO_{2e} emissions by 3.6 Gt. By 2030, 25 billion barrels of oil could also be saved annually, and by reducing travelling related to only education, 5 billion liters of fuel could be conserved. (GeSI, 2015).

Improving logistics has a huge effect on the environment. By using the analyzed information sensors send, logistics may optimize how resources and time could be saved. (Tanskanen, 2015.) ICT enables smarter logistics and mobility. This could help abate CO_{2e} emissions by offering smart solutions and by reducing useless travelling. Furthermore, smart agriculture solutions could abate 2.0 Gt CO_{2e} by 2030 annually. (GeSI, 2015.)

In the case of waste management, for instance, sensors and cameras can recognize when the dumpster is full and send a message to the waste collection vehicle as a result of the IoT (Figure 22). This way the dumpster would not be overloaded but collected in time due to the real-time information. (Tanskanen, 2015 & Wharton, 2015.) Also, the logistics of postal services may be optimized so that there would not be drives unnecessary to the receiver; it is already possible to decide the time of the package's arrival instead of the postman ringing the doorbell of an empty house unexpectedly. Planned postal deliveries save both time and the environment. (Tanskanen, 2015.)

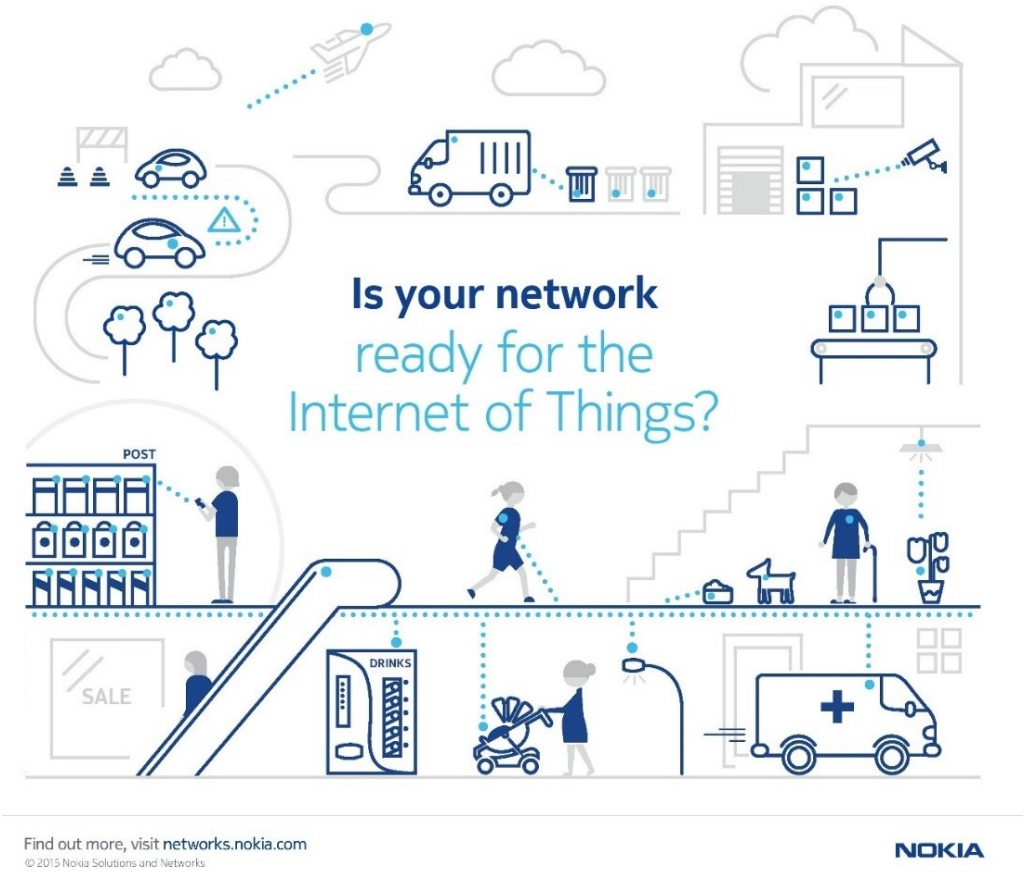


Figure 22, Infographic of Internet of Things (Nokia Networks, 2016a).

The possibility to use devices wirelessly and to remote-control them offers an extremely vast potential to save energy and material and to act in an environmentally friendly fashion. Strategically placed sensors and detectors increase the performance of process optimizing. Measuring is more affordable, when it is possible to read and interpret data and results remotely. (Kotola, 2015.) Various machines, such as ships and cranes, can be driven and their operations optimized alongside the emissions. This also lengthens the working life of the machine or engine, because with better information, the maintenance may be done better and almost in real-time. Maximizing the usability is absolutely advantageous for the environment. (Pesonen, 2016.)

With the IoT and connectivity, remote controlling may also be applied in consumers' everyday lives. According to Tanskanen (2015), heaters could also work proactively by regulating the heating based on weather forecasts. They could read the weather forecasts and automatically anticipate the upcoming weather temperatures; if cold weather was coming, the heating system could warm up the house automatically, and in case of a

warmer season it would correspondingly lower the temperature to respond to the prevailing weather.

According to Rakentaja (2015), it is useful to have a remote control feature when it comes to holiday home temperatures; with the feature it is possible to regulate the temperature in every room singly, for example with a tablet computer that works anywhere with a network connection. This feature helps find the possible heat leaks as well. This is an energy efficient solution for holiday homes for example in Finland, where the cold winter forces to keep the heat on the whole winter in case the owner wants to make even one trip to the holiday home. With a remote controlled heating system, the temperature can be kept low for most of the winter and turned back on a few days before the intended visit to the cottage.

Therefore, the emission savings would be great, since there would be no need to heat up empty spaces anymore. Furthermore, in common homes the heat could be dropped a few degrees during the hours when residents are in work and at school, and warmed up to a normal level when they arrive home (Tanskanen, 2015).

ICT also enables numerous other environmental benefits apart from decreasing emissions and saving energy. By 2030, smarter agricultural practices could be even 30% more efficient, which equates to 900 kg of extra crop per hectare annually (GeSI, 2015). In a field with GPS, it is already possible for a combine harvester to measure the amount of grain and the location where it was harvested from, so for the next year the spots with less grain may be fertilized more precisely to get better crops in the future. Furthermore, there is a potential of 20% savings of food waste and decrease the need for water by 250 trillion liters (GeSI, 2015).

Typically, before the water reaches the end-customer in a large scale water system, there is approximately 20% loss of water. A programmable system with sensors in the necessary places, such as pipes, homes as well as industrial premises, could be connected to cloud services. This system would provide opportunities to resource efficiency because of massive analytical capabilities which could understand usage trends, weather forecasts as well as special events that cloud drive demand. It could also recognize maintenance activities and new housing and factories coming online. (Nokia Networks, 2015b.)

This kind of system has potential to improve water efficiency all over the world due to its better capacity, demand optimization, better network and management of leaks as well as lower unbilled water volume with many more benefits. In the United States, water usage is over 1.3 Tera liters daily, and the programmable system could help prevent water loss, which is 20% on average. This equates savings of 269 billion liters (Figure 23). (Nokia Networks, 2015b.) By 2030, over 300 trillion liters of water could be saved globally with smarter technologies (GeSI, 2015).

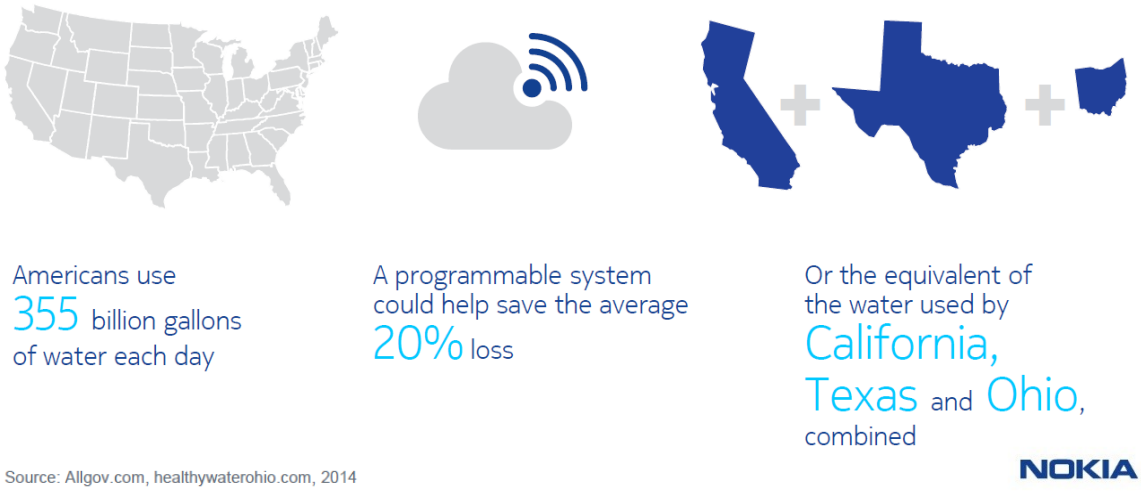


Figure 23, Possibilities in water supply networks (Nokia Networks, 2015b).

3.4.2 Impact of Product Use

The amount of global data transfer is enormous and it is still growing exponentially as there are more and more devices and users connected to each other. Mobile data traffic increases due to increased smartphone subscriptions and also because the average data volume per subscription has continuously increased, especially because of video streaming. In only one year, between Q4 2014 and Q4 2015, there was 65% growth in data traffic. (Ericsson, 2016.) The major part, approximately 80%, of a mobile networks' energy is consumed by base station sites. (People and Planet 2014, 2015.)

To be able to meet the world's growing demand of mobile data the total impact increases. Therefore, resource efficiency and the use of renewables are essential in order to be able to act sustainably. Devices are in use for several years, and use time energy consumption

of the network products is the biggest environmental impact. Nokia has a possibility to decrease energy usage and help prevent climate change by focusing on the power consumption of a product's use time and improving it to keep the operator's network energy consumption flat while its traffic amount increases (Figure 24). (People and Planet 2014, 2015.)

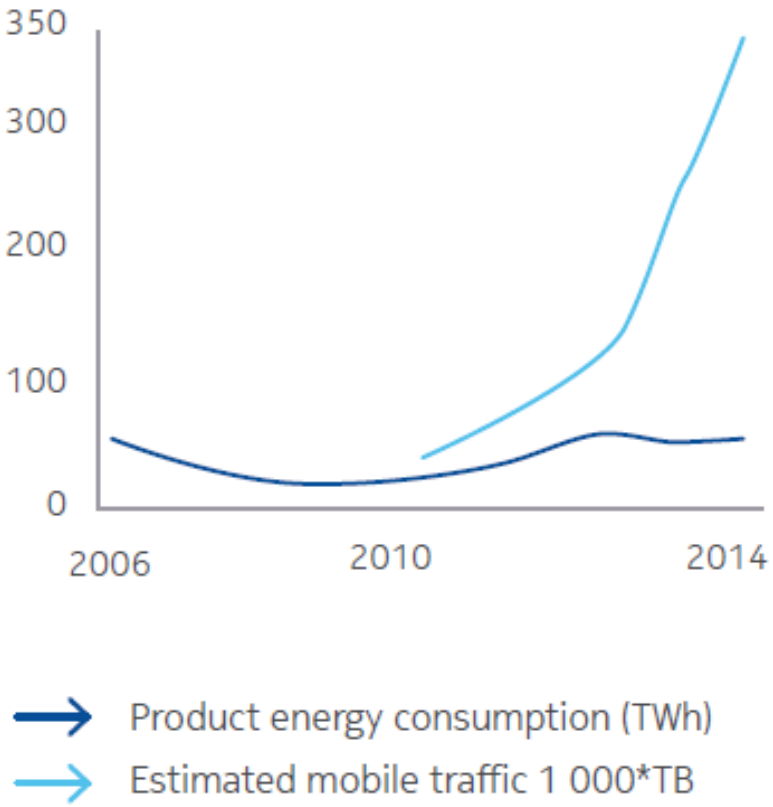


Figure 24, Mobile data's exponential pace of growth (People and Planet 2014, 2015).

According to People and Planet 2014 (2015), every new product Nokia produces allows higher volumes of network traffic while they are in use. This results in improved overall energy efficiency despite the increased total use-time. This is one way for Nokia to cut their customers' emissions in its operations. To ensure that Nokia's new radio products are comparable with similar products on the market, the products' energy efficiency measurements are carried out according to the ETSI TS 102 706 standard.

Nokia continues to develop software and active features in order to use energy more efficiently by adapting to variable network demand. Due to increased smartphone usage and the growing demand for data, the locations and time of use varies, which is why the adapting radio access networks are an efficient solution. (People and Planet 2014, 2015.)

The EU has been paying attention to industrial sustainability and has created the Ecodesign Directive, a tool to help optimize the energy efficiency of a product and to resource consumption. The target is also to get rid of the least performing products on the markets. (European Commission, 2015.) Nokia follows the Ecodesign Directive's updates and additions as relevant based on the company's product portfolio (Lohi, 2015).

Nokia is committed to protecting the environment and managing environmental issues in the long-term in an active, open and ethical way. Environmental aspects are embedded into Nokia's functions: the company is seeking to prevent pollution and to reduce environmental impacts all the way from a product's design to its end-of-life-treatment. This way it is possible to go beyond fulfilling legal and regulatory requirements. (Nokia Code of Conduct 2015.) For example, Nokia has set a company goal to be able to keep the networks' energy consumption flat (Figure 24) by 2020 (People and Planet 2014, 2015).

3.4.3 Dematerialization and Resource Efficiency

The world is continuously moving towards dematerialization, which means the economic system will be less material and energy intensive. It is possible to do more with less, and the functionality of use should remain the same with less material or completely without it. Due to dematerialization, it is possible to use material more efficiently or to use services instead of products. (EWWR, 2015.)

ICT and connectivity may help increase the usage of already existing goods as well as replace physical products with licenses for digital form substitutes. This decreases manufacturing (Heino, 2015), which in turn carries remarkable environmental benefits (Orts & Spigonardo, 2015). The Internet and ICT allow delivering a growing amount of services and products online, which uses less energy and potentially saves resources during production, storage and delivery (Houghton, 2009). Also, according to Heino (2015), it is possible to boost material efficiency with connectivity and visibility.

The positive impacts of connectivity may, therefore, be found in the situations that do not require ownership of physical products, but rather a license to use them (Tanskanen, 2015). Having a network is necessary, because the Internet allows customers and the services to be anywhere in the world. A broadly working Internet access that is enabled by connectivity could bring a major positive impact on the climate and the environment.

People can use millions of applications in their daily lives as substitutes for physical goods. Instead of buying a flashlight, a mobile phone user can download an application that enables him or her to use the phone a flashlight. Moreover, calendar applications enable a shift from a calendar book to an electric calendar, which may also be synced between different devices and shared to other people. Material is saved when it can be replaced with software (Tanskanen, 2015).

As an example, the physical form of letters has been replaced by e-mail and it has created a fast way of communicating with an exceedingly small environmental footprint; there is no need to use paper for letters and envelopes, and to collect, sort and deliver them worldwide: sending an email does the same electrically and reaches the receiver immediately. (Houghton, 2009.)

Nokia's mobile phones also helped to dematerialize the economy by including physical products in the devices and replacing them with services. The mobile phone users did not and do not need to buy a camera, navigator and music player etc. separately even today, because they are all included in the mobile phone (Castrén, 2013). According to calculations verified by PwC (PricewarehouseCoopers), if 100 million people used mobile phone instead of buying music player, camera, video camera, PC, fixed-line phone and car navigator separately, it would reduce approximately 73 Mt CO_2 each year. (People and Planet 2012, 2013.)

Services that work entirely through Internet access, like *Netflix* and *Spotify*, have changed the way people watch movies or listen to music, because they are available anytime and anywhere. In this manner, connectivity saves material resources and time, and improves quality of life, since it is possible to only pay a monthly payment and have access to everything without going anywhere. DVD and CD manufacturing has decreased, since all that is needed is an Internet connection in a mobile device. (Tanskanen, 2015.)

Uber, the mobile application driven transportation network company, has already provided a billion car rides globally (Uber, 2015). This has occurred without the company owning a single car (Orts & Spigonardo, 2015), but by using the drivers' already existing cars instead. Furthermore, usually people's cars are in use less than 10% of the time (Orts & Spigonardo, 2015), so it is resource efficient to increase their usage time instead of manufacturing cabs.

Therefore, in addition to the positive impact on employment, lots of resources are saved, as the application enables people to find a ride through connectivity when they need to instead of owning a car. Even the payment is done via the application, so there is no need for a coins and bills in a wallet, nor making a money transfer through mobile bank. Therefore, it also saves lots of time.

Also, spaces may be used communally instead of creating new ones. Airbnb connects people to travel experiences in 190 countries (Airbnb, 2016), and therefore lessens the need to build new hotels and therefore saves materials. Again, this is possible with connectivity and visibility, since databases help figure out what and where the things that people need are. When the information is gathered together, analyzed and shared effectively, there are huge savings in material, resources as well as time and money. (Heino, 2015.)

Furthermore, instead of having an office of your own or going to an employer's office, people can now work from anywhere and anytime, since there is basically no need for anything apart from a laptop computer and/or a mobile phone with Internet access. Digital form has replaced paper archives, which means that location is not important, when the access to information happens with a mobile device or a computer. Many workplaces also allow distance work days: when employees can stay at home instead of driving to work and producing CO_2 emissions, it both satisfies employees and reduces emissions (Tanskanen, 2015 & SYKE, 2011).

Distance work that is enabled by connectivity increases wellbeing, protects the environment, improves the employee's quality of life, reduces costs and increases productivity, which is beneficial for the employer, too. It encourages new ways of building sustainable economy and creativity. The way people work has already changed,

but to make it easier to combine everyday life with work, distance work may play a significant role improving life quality. (Tanskanen, 2015 & SYKE, 2011.)

One mutual computer storage system in, for example, the workplace saves energy and is a concrete advantage when improving sustainability in energy and resource efficiency (Kotola, 2015). Computer capacity will shift to the cloud, and more and more information will be storaged electrically and accessed easily.

For example, Nokia handles its patenting operations almost entirely electronically, which minimizes the amount of paper used during the process, therefore saving trees (van Waes, 2016). Furthermore, the potential to replace study materials with electronic books in e-learning could save 91 million tons of paper by 2030 (GeSI, 2015). This is enabled by fast connections and data processing. It is possible to optimize the environmental factors of the data storage in order to avoid heat and energy waste (Kotola, 2015).

Furthermore, Cisco (Ellen MacArthur Foundation, 2016) estimates, that connectivity improves workforce productivity through the personalization of the workspace. The workspaces can be optimized by connecting all office-related functions into the same platform; lighting, heating, air conditioning, etc. This would also save energy costs by approximately 7-8%.

Material and its value may be reused by circular economy, which is a nontraditional economic model for industrial economy. It strives to create added value through smart solutions and services. (Sitra, 2016.) Connectivity may, for example, help emerging economies skip heavyweight upfront investments and solutions that are material-intensive (Ellen MacArthur Foundation, 2016). Even the European Commission has adopted the Circular Economy Strategy to boost global competitiveness, to act sustainably and even to generate new workplaces (European Commission, 2016b).

A huge number of products are no longer in use just because their current owner has no need for them anymore. Instead of keeping them in the closet or throwing them away, they can be reused by someone else, which decreases the pressure to create new goods.

Before wide Internet network, it took time and effort to find a buyer because the seller had to be present on the flea market waiting for the possible buyers to show up. Nowadays, connectivity helps find a new owner easily from a wide area. The seller can simply leave a sales advertisement on a market place site and wait for the buyer to come to the seller. For example, the Swedish site *Blocket.se* has over one million users daily, and almost 80% of Swedes have bought or sold something in Blocket.se (Blocket, 2016).

Selling used goods also brings savings to the seller, saves money for the buyer because of the lower price of used good. Moreover, it is sustainable, since there is no need to use materials to create a new product, when the already produced ones are still good to use.

Material resources may also be saved by commonly used products, since there is no need for everybody to have their own devices, vehicles or summer cottages, if they are not used on a daily basis: it would be possible to have, for example, a reservation system and to use a common device, such as a power drill. In a housing cooperative, the reservations could work online and in real-time, with the same principle as a laundry room. For the system to really work, common devices, vehicles or spaces need to be easily reservable and usable, because the more users they have, the more material efficient this system is. (Heino, 2015.)

According to Heino (2015), the general mindset is changing, and a used product is no longer thought of as waste but rather as a useful good or material. When databases carry the information of the availability and location of a product or a material, it is easier for the product to find its way to the new owner or for the resource to be shared. Therefore, less products will go to waste; the source of the waste is an effective place to start when managing waste (EWWR, 2015).

4 Challenges, Changes and Possible Solutions

4.1 Unlimited Possibilities in All Ways

Because today the amount of technology that operates through connectivity is huge, and the IoT will only increase it, the society is more vulnerable in many ways. If the networks were suddenly out of order, the world would be exposed to major risks: everything that is normally enabled by connectivity, such as money transfers and phone calls, would stop working.

All technology can be used both for good and for bad. According to professor Stephen Hawking (BBC, 2016), the progress of science and technology will also bring "new ways things can go wrong", but as Pesonen (2016) states, the correct use that aims for positive outcomes should not be prevented only to prevent the possible misuse of the technology.

Nokia has also identified challenges, which are an increased importance of privacy, the demand for high ethics, the importance of an attracting and retaining talent, climate change and also the need for better resource efficiency. (People and Planet 2014, 2015.) According to Rajeev Suri (People and Planet 2014, 2015), Nokia has all it takes to release the potential to improve different areas. Suri believes, that it could be possible to improve on many areas, for example, decrease environmental degradation and resource consumption, and improve learning, work, health and wellness in new ways, "on technology grounded in real human needs".

4.2 Economic Impact

The nature of work will change, and the negative impact of it is that due to automation some jobs will disappear. (Nokia Technology Vision 2020, 2015). Individuals are empowered through ICT, and some businesses may see the digital density as a threat (GesI, 2015). Digitalization will cause even some knowledge jobs to disappear, move them to be done by customers themselves and also to outsource them to countries of lower wage levels. Still, the digitalization of knowledge work should show as an increase in total productivity, and exploiting digital technology may also improve wellbeing at work and even save jobs. (Pohjola, 2014.)

The price of connectivity and ICT devices may be an issue to people who have a lack of finances. High prices may prevent access to them, which may in turn generate economic challenges because of not being able to be connected. No one should be left outside information society, as the Internet is becoming a more and more important tool to it, and people use it daily to conduct all kinds of activities online from education to business transactions (U.S. Department of Commerce, 2000). For example, in developing countries, creating a bank account may be slow, but due to mobile banking and mobile money applications more people can benefit from the opportunities provided by them (Forbes, 2015).

Furthermore, according to Okkonen (2015), in Myanmar the decrease in SIM card prices has allowed common people to purchase one, when earlier it was possible almost only for very limited amount of the overall population. Now that the country is developing fast in terms of network infrastructure creation and increased connectivity, it creates new possibilities for e.g. early education in the more remote areas of the country.

As paying has become easy via mobile application purchases, it sometimes causes mistakes and unintended bills for the users. According to Nordea (2016), for example a childrens' mobile game may cause a bill of hundreds or even thousands of euros for the child's parents, if making purchases is possible directly from a credit card after downloading a paid expansion and not disabling the possibility for purchases. A child does not understand the value of the purchases, which may cause the bills to become extremely high. The Finnish Competition and Consumer Authority (in Finnish: Kilpailu- ja kuluttajavirasto) have been contacted in over ten cases related to mobile games targeted to children during a period of less than month in January 2016. (Nordea, 2016.)

Nokia and Fundacíon Proacceso, an NGO, started cooperating in 2014 to reduce the digital divide in the low-income areas in Mexico. With the help of Nokia, Fundacíon Proacceso launched a dedicated *Markers Lab* in July 2015 with the intention of connecting highly marginalized and densely populated communities in order to include them to quality education and technology. (Nokia, 2015b.)

Access to education is a challenge in some developing countries (GeSI, 2015), but Markers Lab intends to provide educational selection and classroom tools. With this help

the communities will be able to reach their creative and innovative potential in a new space. Markers Lab is designed for the hands-on use of many technologies, e.g. mechanical, electrical and digital, and it also offers different workshops in creative tools and 3D design and fabrication with 3D printers. In addition, there is access to computers and the Internet. (Nokia, 2015b.)

The cooperation both bridges the digital divide and uses the educational benefits of technology. These communities would likely have no access to these kind of tools in any other way, but due to Markers Lab the people of these communities have a possibility to find jobs and share their talents with their families and communities. (Nokia, 2015b.) This way the increased knowledge and skills may have an impact on more people than just the ones actually using Markers Lab.

4.3 Social Impact

4.3.1 Privacy Protection

In this section, privacy protection includes both data privacy and people's right to privacy. According to EU law "everyone has the right to the protection of personal data", and the persons or organizations collecting and managing this personal data are obliged to protect it from misuse (European Commission, 2016a). International human rights law on the other hand provides a framework for individual privacy rights (United Nations, 2016a). Thus far 168 states have ratified the International Covenant on Civil and Political Rights, which includes the right to privacy (United Nations, 2016b).

Privacy protection will be a challenge as more and more of people's information is gathered through applications and on the Internet. Improving the flow of the information may increase the risk of weakened privacy, even if it may be a channel to get your voice heard. (Baijars, 2016). Private information may end up in the wrong hands, and mass surveillance is possible without people knowing they are being observed.

In June 2013, a former Central Intelligence Agency (CIA) and U.S. Government employee Edward Snowden revealed classified documents of the United States National Security Agency (NSA). According to the leaked documents, many global surveillance

programs filtered data, gathering information and phone calls and decoded people's encrypted messages. (Time, 2013.)

Snowden decided to leak the documents when he found out how widely these surreptitious spying programs were run, and the majority of people were not even aware it was possible. According to Snowden, the risks of the government's surveillance are too high, and every human has a fundamental right to be free from surveillance. (Time, 2013.) After the documents were revealed, Germany opened an investigation regarding NSA's cell phone tapping of Chancellor Angela Merkel (Huffington Post, 2014).

According to Church & de Oliveira (2013), the mobile phone users who do not pay for SMS but use WhatsApp instead, rated privacy as the most valuable part of SMS messaging. With WhatsApp, privacy was named as one of the three identified problems, as the application reveals the last time the user used WhatsApp, or at least when he/she read the message. Where WhatsApp's nature is social and conversational, SMS is found more reliable and privacy preserving.

Localization and mapping of people is correctly used in democratic countries, but in dictatorial or totalitarian countries those features may be misused. According to Baijars (2016), for example, hackers using personnel data could use that for example in child trafficking in developing countries. If the information of people mapped in rural areas leaked into wrong hands, it could be a risk. Still, if mapping was used to chart people in rural areas, it could help prevent people from falling into the hands of smugglers. Therefore, the choice to not use mapping would be a risk, and disuse of potential technology might end up being a greater risk.

An extreme example of the challenges of privacy is highjacking a self-driving car, so there's a downside in many connectivity-enabled information. According to the Federal Bureau of Investigation (FBI) (Tech Times, 2016), increased connectivity makes vehicles vulnerable. Computer and smartphone hacking has long been an issue, but when vehicles become smarter, also they are left vulnerable to cybersecurity threats. The FBI and the NHTSA have warned the public of remote exploits of cars in the U.S. A vehicle may be hacked remotely, and it is possible to for instance shut down the engine and disable the breaks. (Tech Times, 2016.)

Hacking may be used also in medical devices. Dick Chaney, the former Vice President of the United States, had the defibrillator that was implanted into his heart (implantable cardioverter defibrillator) modified by his cardiologist's recommendation. He was afraid it could be wirelessly hacked by an attacker and used to kill him. Some medical implanted devices, such as Cheney's one, can be wirelessly accessed by the doctors. In 2007, Cheney's defibrillator was replaced by a new one, of which the manufacturer had disabled the wireless feature in order to prevent the threat of terrorism. (Cheney et al., 2013 & CNN, 2013.)

According to Vänskä (2016), the misuse of medical data is a great challenge, because there may be very private and sensitive information that people would like to keep only to themselves. Networks should be safe and protected, so that this type of sensitive information could not be hacked.

Due to privacy protection' importance, Nokia is weaving the networks, data and device technologies for the communities and businesses so that they do not have to worry about privacy and security (Nokia, 2016d). Technology is able to solve the privacy issues (Oksanen, 2015).

4.3.2 Stress Caused by Continuous Availability

According to Pietilä (2015), continuous availability has led to a situation that causes stress to people. Mobile devices and networks make it possible to contact almost anyone anytime, and the expectation of how quickly people should answer has changed. Whereas a few of decades ago, before emails and text messages, a letter reached the receiver in several days or even weeks and waiting was normal, the latency is now minimal compared to those times and people expect to reach everyone even immediately.

This also raises the challenge of how to separate the really important cases from the others, and having many channels for interaction means that it takes time to react to anything quickly (Pietilä, 2015). Will Hutton, Chair of the Big Innovation Centre at The Work Foundation states (BBC, 2012) that being online and available 24 hours a day is not good for an individual worker's performance. People need time and periods when they do not need to react instantaneously. Continuous availability has a negative impact on an individual's well-being.

Mobile phones, computers and other devices may be a source of stress when they are used out of working time, so the German car manufacturer Volkswagen decided to turn some of their employees' Blackberry emails off 30 minutes before and after their flexible working hours. Therefore, between 18:15-07:00 some employees are not receiving any emails. Blackberry servers stop sending emails to separate the employees' work and home lives, which, according to them, had become too blurred. (BBC, 2012.)

Because the Internet offers so much content and almost everything may be found when wanted, being online also takes time from face-to-face relationships. Smartphones are with people everywhere, and especially young people are accustomed to using them all the time; while walking, watching television or spending time with friends. (Pietilä, 2015.)

Even the concept of normal conversation and interaction has changed. It is more and more usual to have a virtual conversation with someone else while seeing a friend face-to-face. People have multiple conversations simultaneously, even when having a lunch with a friend. Despite having lots of friends in social media but not enough face-to-face interaction may cause people to feel lonely. (Pietilä, 2015.)

Using mobile phones has become so usual that cafés and restaurants even have to encourage people to stop looking at their phones and to have normal conversations without distractions. For example, not offering Wi-Fi (Figure 25) or offering drinks from glasses that stand up only if there is a mobile phone under them make it hard to look at the phone while having a drink with friends.

Figure 25, Connectivity decreases normal face-to-face conversations (9GAG, 2015).

A study on how the presence of mobile devices affects relationships shows that conversations without the presence of mobile communication technologies were rated superior compared to those where mobile devices were present (Misra et al., 2014). Age, gender, ethnicity or mood did not have any effect on the results in the study, which would suggest that this change is global.

Furthermore, according to speech therapist Päivi Huusko (Yle, 2015a), Finnish parents talk to their young children less than before because they spend time in social media and are not present in the children's life as much as before. This has caused speech delays in three-year-olds. Due to the decreased interaction between parents and children, practicing speech has decreased.

A child learns to speak by imitating and needs an adult or a model to do so, because without it language learning and the acquisition of speech are impossible. Instead of speaking to a mobile phone or reading news during for example travelling to the shop, talking to a child about things seen along the way has a positive impact on the development of a child's speech. (Yle, 2015a.)

Forgetting a mobile phone at home may even cause anxiety, since people are not used to being without it anywhere. *Nomophobia* is an unofficial term used for "no mobile phone phobia", which is related to smartphone addiction. The phenomenon is quickly growing especially in Asia, and the phone addicts are younger than earlier. (BBC, 2015.)

In Asia there are 2.5 billion smartphone users, and there have already been several accidents caused by using a smartphone and not paying attention to the real world. People have walked off piers and fallen into drains while looking at their phones and checking Facebook, for example. (BBC, 2015.)

According to researchers (Jeong et al., 2015), in South Korea 72.2% of 11 to 12-year-old children have a smartphone of their own, and 25.2% of them have an addiction to smartphones. They spend an average of 5.4 hours with their phones on a daily basis. There is a great difference between children and adults, since the adults spend approximately 3.8 hours with their phones a day and 8.9% of them have an addiction. In Singapore, the country with one of the highest smartphone penetration rates with a connectivity score of 5.47 of 10 (Connectivity Scorecard, 2013), there is already a cyber wellness clinic for recovering smartphone addicts (BBC, 2015).

Media content type and user characteristics have an effect on the possible addiction; low self-control and a great amount of stress are likely to lead to an addiction alongside with using the smartphone for gaming and entertainment (Jeong et al., 2015).

4.3.3 Health

Social media may cause dissociative identity disorder (DID) due to the many channels in the Internet (PRNews, 2009). DID is a condition in which at least two distinct identities or personality states are present in an individual that alternately takes control of them (Psychology Today, 2014). Social media has given individuals the ability to become many different people simultaneously (Forbes, 2011), since people can have many accounts for different meanings: LinkedIn for business life, Facebook for friends and Twitter for yet another target group. This has made it possible for individuals to create multiple personalities online leading social media to encourage to DID. (PRNews, 2009.)

Still, the future of social media will promote so called single profiles and single logins which make updates across many social media platforms at the same time. This will eliminate multiple personalities, because the chosen personality is “authentic”, and permeates across social media interactions. Therefore, updating information and publishing content real-time will be more efficient, but it again may cause privacy issues. (PRNews, 2009.)

According to Vänskä (2016), refining the medical data and biodata of patients is a challenge, and there will be lots of this data gathered by the patients themselves. The raw data alone is not enough to tell the doctors what is relevant. It is important to discover the deviations and visualized trends of the data, so a mere list of measured blood pressures is not useful.

It is a challenge to have all the advantages from the medical data, even though most of the data is already moved to the cloud, and for example EKG data can already be analyzed from the cloud by a computer with different algorithms (Vänskä, 2016). Still, wirelessness and connectivity, together with data analytics and automated behavioral coaching, have great potential to increase substantially and to help prevent serious illnesses from developing while also decreasing medical costs, as well as the workflow costs of patient care (Harju, 2015).

Today, people are more willing to take control of their own health. They are not always, however, any more willing to bear the cost – at least at the level of cost that health care is provided today. If digital health solutions can offer the same benefits at a lower cost, however, consumers would increasingly choose to pay instead of relying on other people deciding on their behalf. (Harju, 2015.)

When it comes to telemedicine, the connections must be reliable, because loss of connection could, in the worst case, result in the patient’s death. The same applies for telesurgery, because even though operators can perform surgeries despite significant delays, latent video feedback is considered problematic (Rayman et al., 2006). As the networks’ infrastructure and connectivity develop, 5G may bring many positive opportunities for telemedicine.

Mobile devices have, in some cases, decreased sports activities among children, because they spend time playing on computers and mobile phones. By encouraging children to exercise with gamification the sports with wearable technology and applications like Zombies, Run! it is possible to make sports more fun and motivating. The entertainmental layer may be an incentive, and having information in the cloud makes it possible to see the improvements gained from exercising, which again may work as a motivating factor (Soute et al., 2009).

4.3.4 Other Social Issues and Improvements

According to Rajala (2016), the greatest challenge regarding the development of connectivity is censorship, which is the government's way to limit the possibilities to improve the access to information. For example, Turkey has blocked Twitter, Facebook and YouTube, last in 2015 (Yle, 2015b).

Also, governments in some countries may be interested in misusing personal data (Kolehmainen, 2016). According to the net neutrality principle, all data should be treated the same by governments, and if the government decides to block access, the possibilities for development are limited. Furthermore, when knowledge is available and there is access to international information, the power of the local media in the government's possession is decreased (Kotola, 2015).

Because almost anyone can access the Internet, people may not be who they claim to be, and even identity thefts may occur. According to Vänskä (2016), due to the possibilities for anyone to become well-known person via the Internet causes risks regarding rightful information. It is easy to appear as an expert despite the fact that the person may not have scientific information, only opinions of his/her own. A famous blogger may reach many readers with his/her blog, and people might believe that the stated opinions are facts. People do not know who to believe: a professor with scientific knowledge, which is results of years of independent studies and research, or a charismatic blogger without any scientific evidence to back up his/her opinions.

Today's world demands people to have better media literacy, as there is so much information available and sources are not necessarily always completely reliable. This

causes uncertainty of what is true and what is not, and the created image might not live up to expectations (Pesonen, 2016).

Understanding what to believe as well as what you can write in the Internet or upload there is challenging, especially with children, who do not always understand the risks. In today's information society trolling and propaganda also cause anxiety and uncertainty. It is easy to access information very fast, but the reliability weakens when sources are not verified. Still, freedom of expression has widened, and the positive impact of access to information is massive.

According to Seppälä (2011), the spreading of western cultures and the English language have caused dissatisfaction in China, due to English having an over-emphasized position in schools, because it has decreased the focus on other school subjects, such as Mandarin Chinese. According to Nunan (2003), the spreading of English has caused problems such as confusion and inconsistency in policies in the Asia-Pacific region.

The dominance of the English language has its own impact on cultures around the world, because it brings elements of the western culture to other ones, which may even lead to intercultural mixing. All over the world people watch the same western movies in English. (Kolehmainen, 2016.)

Despite the positive effects of Internet-based communication and freedom of speech, there are also many risks related to social interaction. The Internet enables bullying because of the possibility to act anonymously (Kotola, 2015 & Baijars, 2016). According to Baijars (2016), in some cases social media distorts children's identity and development into adulthood, because they keep reflecting themselves to it as they are growing up.

Studies also show that building a positive self-image may be overly difficult if the ideal-me is too far from the real-me. When a young person has weak self-esteem and a twisted self-image, media increases the risk of him/her developing an eating disorder because it normalizes dissatisfaction of your own body. This does not apply to girls only; boys also feel pressure regarding their appearance, and the impact of media has been increasing during this millennium. (Salokoski & Mustonen, 2007.)

Nokia's *Dreams* project focuses on the benefits of the Internet by getting positive feedback; 30 days' challenges are designed to improve children's and young people's self-esteem. Dreams is challenging the whole school community to dream and to take concrete steps to reach these dreams. The Dreams project aims to improve the pupils' life skills and to encourage them to find their strengths. Social media is used alongside the Dreams project. (Baijars, 2016 & Lasten ja Nuorten Säätiö, 2016.)

4.4 Environmental Impact

Although ICT and connectivity are, in many ways, enablers to more sustainable and energy efficient actions, there are also challenges related to, for example, increasing energy consumption that are not yet completely solved. Even though sharing economy is both material and resource efficient, it has its drawbacks; for example, streaming video consumes much more energy than making a regular phone call, not to mention streaming Netflix online, and exactly these pastimes are gaining popularity. (Tanskanen, 2015.)

In the future many non-electronic products that are in use today will include electronics due to the IoT. Energy usage will therefore increase due to the increased electronic devices that require connections. (Tanskanen, 2015.) It is crucial to manage energy more efficiently in order to keep energy consumption flat as the demand constantly rises (People and Planet 2014, 2015).

There will also be more products that contain electricity, since the IoT will connect so many physical objects. More and more traditional and non-electronic products like clothes, furniture and products that contain electronics will communicate with each other and possibly be remotely controlled by their owner. This requires electronics, which may be an invisible addition to a consumer's energy consumption. (Tanskanen, 2015.)

Due to the new online devices and gadgets, the IoT requires both energy and raw materials. These new gadgets will probably replace many of the older devices, which would still work, but are not that "smart". These devices, e-waste, would need to be disposed of. (Wired, 2014.) In 2013, the amount of discarded e-waste was already 53 million tons, and due to the IoT, the amount is expected to accelerate. It definitely needs

to be taken into account for the development of a sustainable world. (Advanced MP, 2013.)

Still, these challenges are not insurmountable. A network connection and smart devices could easily be upgraded instead of manufacturing new ones, which again would extend their lifespan. Open source plays a key role in upgrading devices and preventing them from ending up as waste. Open source makes it possible for many communities of developers to invent solutions for the devices and products to be updated. (Wired, 2014.)

The use of ICT is constantly increasing and the challenge is how to carry it out. Even when energy consumption may be kept flat, there is a need for sustainably produced energy from renewed energy resources. (Tanskanen, 2015.)

Mobile data usage is growing year by year because there are more devices for more users to stream videos, access the Internet and use social media with an upward trend (People and Planet 2014, 2015). Today, ICT directly causes more CO_2 emissions, which is currently approximately 2% of all global emissions (GeSI, 2015) and comparable to the aviation industry globally. (Nokia, 2015a.)

ICT emissions will decrease in the course of time (GeSI, 2015) due to more efficient solutions. For example, old but functioning devices can be refreshed to new generation products by downloading software remotely and updating the circuit board. This way it is possible to prevent the prediction of additional devices and to be both resource and energy efficient.

Nokia may potentially make a difference by helping operators reduce their energy consumption (Nokia, 2015a). The IoT will connect more than 50 billion devices by 2025 (Kolehmainen, 2015). There is a huge need for base stations and working networks, and the base stations must be as environmental-friendly as possible.

Therefore, Nokia Networks has developed zero CO_2 emission base station site offering, the *Single RAN Advanced.* It was launched in February 2015, and it enables operators to reduce energy consumption by up to 70% in their networks (Figure 26). (Nokia Networks,

2015c.) Renewables can be used in the remaining 30% (People and Planet 2014, 2015). The aim is a completely carbon neutral operation (Nokia Networks, 2015c).

Building wide and working connectivity is possible in this manner without releasing CO_2 emissions, even when demand increases. It is designed to decrease carbon dioxide emissions and to make ease the use of renewable energy resources. With the over 20 new services and products, it is easier for customers to achieve their cost and reductions targets. (Nokia Networks, 2015c.) Nokia also ensures that every new product is at least 15% more energy efficient than the previous one, because of more efficient hardware and software, for example (Nokia, 2015a).

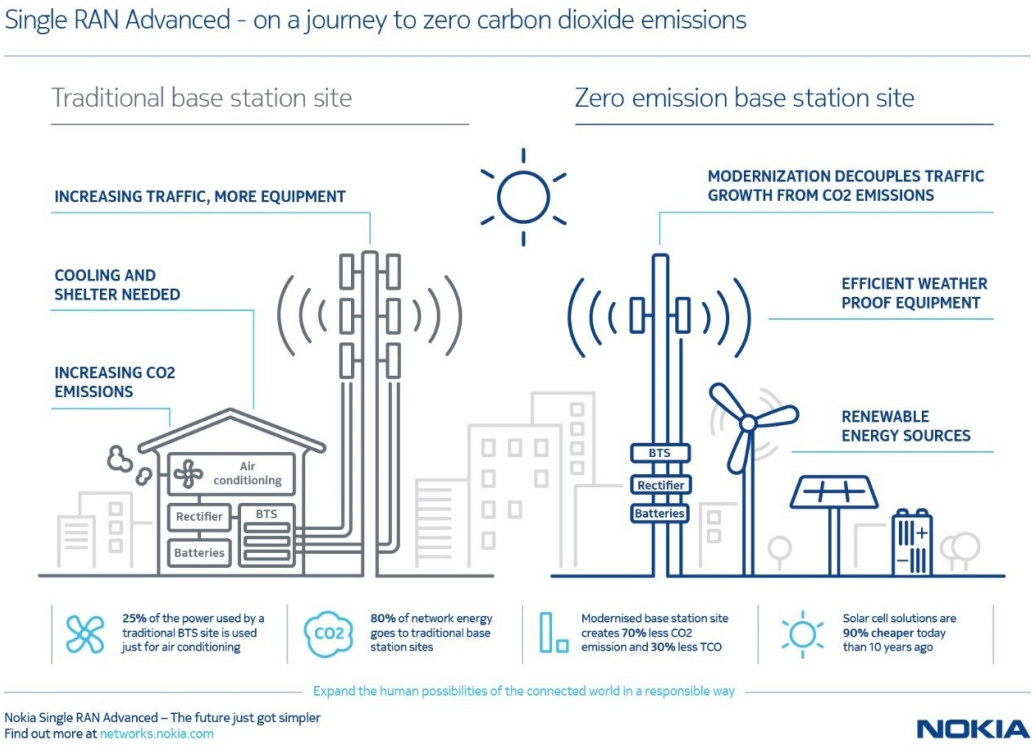


Figure 26, Single RAN Advanced infographic (Nokia Networks, 2015a).

In 2014 Nokia had more than 20 smaller energy consumption projects in the field of telecommunications networks with the company's customers. Furthermore, during that time product energy efficiency measurement was improved. Nokia *iSON Manager*, on the other hand, is a self-organizing networks solution designed to minimize LTE networks' energy consumption. Korea Telecom invited Nokia Networks to create a

solution, which would automatically optimize network energy usage. The pilot project was a success; Korea Telecom was able to reduce 40% of the consumption, since Nokia iSON Manager shut down particular frequencies when they were not needed in order to save energy. With iSON Manager's self-figuring, -optimizing and -healing capabilities operators can reduce the amount of energy used. (Nokia Networks, 2015e.)

Moreover, according to the International Energy Agency (IEA) (2016), investing in renewable energy sources and improvements in energy efficiency are the most important reasons why energy-related greenhouse gas emissions have stayed flat for two years a row already, staying in 32.1 billion tons in 2015. This is remarkable, because the earlier four periods during which the energy-related emissions have stayed flat were associated with a global weakness in the economy; for the first time greenhouse gas emissions are decoupled from economic growth.

5 Conclusions

Connectivity has already changed the world permanently and its impact on sustainable development is also enormous. Connectivity and ICT provide many opportunities that may help both people and industries to act sustainably. This is important for both today's society and future generations. As the Internet of Things will connect billions of devices, it will only accelerate the growth of available opportunities to benefit from.

As the cases in this master's thesis show, connectivity has already provided solutions for developing the society and improving both environment and economy. In the economic field, the greatest impact seems to be in smart solutions, which save resources, time and money. Connectivity makes it possible to provide more services for people to use all over the world, while often lowering the negative environmental impact. The impact on employment also seems to be great especially in the future, since the IoT will enable various new business opportunities such as Airbnb and Uber, regardless of physical location.

For the people of developing countries, this kind of impact on employment might be even more important than for the developed economies, because connectivity enables maintaining livelihoods in periphery, too, and helps to lift people from poverty. By providing opportunities for people and industries, the impact of connectivity, in essence, appears to be a globally sustainable economy in the future.

Positive social impacts could be described as being more various than the economic and environmental impacts. Despite the difficulties in measuring these fields comparably, it is obvious that the impact in the social field is huge. It covers e.g. health, education, political field and freedom of expression. The solutions enable opportunities to benefit from technology more, as in addition to people, billions of devices will be connected because of the IoT. That, yet again, offers more information remotely through sensors connected to cloud services, and when the data can be refined properly, technology may be used in a more specific manner.

This leads to impacts on healthcare, which will be more digitalized in the future. Through digitalization healthcare may improve peoples' health and save more lives. Together with

savings in the economy and resources, it seems to be an extremely positive outcome for people, the economy and the environment.

Smart devices also play an important role in increasing safety among people during both working hours and free time, in addition to increasing the quality of life with an entertainment. The importance of equal opportunities is most visible through Internet access, which connectivity enables for more and more people.

This allows the improvement of education, for example: through connectivity there are limitless possibilities for e-learning and increasing people's knowhow globally. Therefore, digital inclusion could help people to live better lives in this connectivity-enabled world. In a connected world, the human capital is also more extensive, since the more it is possible to benefit from people's knowledge, the more innovative solutions there may be in the future.

It is also worth noticing, that connectivity enables people to claim rights to themselves by retrieving information from the Internet that provides the same content for everyone. The Internet has already been used for making an effect on political chains of events, and social media will presumably have an even greater impact on the world in the future. In places where connectivity is the only infrastructure people can rely on, it provides a way to communicate with the outside world. This may help minorities report violations regarding human rights and allow them to receive help.

The positive environmental impact is also significant, and the greatest potential of connectivity seems to lie in helping prevent the climate change caused by man. Sustainable choices help keep the world healthier and ensure that there will be resources in the future as well: dematerialization increasingly enables people to do more with less. The possibilities dematerialization provides improve sustainable development in many ways, especially since technology keeps on developing exponentially. This means that physical products may be replaced with services without ownership, which encourages the world to become less material-centric.

In the future, the almost tenfold abatement of CO_2 compared to the amount generated by its deployment provides an efficient way to turn the increasing CO_2 trend down while

economy can keep on growing. Because in 2015 the energy-related CO_2 emissions were finally decoupled from economic growth, it is obvious that focusing even more on energy efficiency and renewable energy, ICT may truly contribute immensely to preventing the climate catastrophe without decreasing economic growth.

There will also be challenges regarding connectivity in the fields of sustainable development. Not everyone is connected yet because of various issues, so opportunities are not globally equal. The digital divide prevents people from benefiting from the ICT, and therefore economic, social and environmental development are not possible everywhere in the same scale as in areas that have good connectivity. It is surely a challenge to be able to include everyone, but over time the goal becomes closer.

For the people that are already connected, connectivity sometimes appears to create stress, because nowadays everyone "should" be available all the time. It may be even harder for people in the near future to separate work from free time, because even when you are on vacation it is easy for the office to reach you. This has obviously already created some issues and, in the end, it may decrease people's efficiency at work. Thus the impact of connectivity is not always positive. The way people work is expected to change in the future due to the IoT and developed technology. For the economy, the fact that many jobs will disappear because of automation may become a challenge.

Due to the IoT, the usage of devices will still increase, and this means that the need for energy will increase exponentially. Also, the need for material may increase because the increasing amount of technology used in products. Answering to the mobile traffic demand while keeping the network energy consumption flat is a challenge, but it seems to be reachable in a few years already. Still, the energy that connectivity and industries demand globally should come from renewables because of sustainable development. This is also a challenge: how to change the policies in this world for good.

Privacy protection, again, may be the biggest risk in the future, as information ending up in the wrong hands might be a risk for people. The IoT enables devices to communicate with each other, but errors in communication or a sudden lack of connectivity might also create risks. Some of these risks are smaller, but in some cases hacking information or a device or system may be even a life-threatening risk for people. Because the legislation

appears to change slowly, there will probably be many issues that could have been solved, if the legislation had anticipated already beforehand the possible future risks and prevented misuse by law. Privacy protection should definitely develop the way possible leaks are minimized to protect people.

Some of the changes are unavoidable, and therefore it is necessary to identify them in order to make improvements in these fields and prepare for the changes that may occur. Still, the results of this research show that many of the challenges will also be partly solved when negative changes are replaced by positive. For example, even though jobs will disappear, the IoT will also create lots of new ones. Moreover, technology can also help solve many privacy issues.

Furthermore, focusing on the possible changes makes it possible for Nokia and other parties to develop actions in the early stages in order to minimize the negative impact. After all, the risks are slight compared to the benefits that connectivity can provide. Deciding not to use the technology would definitely be a disadvantage because the positive impacts of connectivity and ICT are extremely massive.

The material used in this research shows that the positive impacts in one field often lead to other benefits in also in the both two remaining sustainable development fields, which is a remarkable finding. For example, improving resource efficiency with the help of connectivity saves raw material, but also increases GDP and creates new jobs. The same principle applies to situations where connectivity and ICT help other industries decrease CO_2 emissions: at the same time, they improve people's health through cleaner air while cutting medical costs. Healthcare IoT, again, provides resource-efficient solutions, saves money and makes it possible to take better care of patients.

Therefore, instead of making compromises between economic, social and environmental fields to balance them, the results of focusing in one dimension may very likely result in a win-win-win situation with smart connectivity solutions. This discovery provides people, industries, stakeholders and other parties with more reasons to act sustainably because of the possible insuperability of the expected results.

6 Summary

The aim of this thesis was to research both the positive and the negative impacts of connectivity in the fields of sustainable development (economic, social, environmental), and through these findings allow Nokia and other parties to recognize their most relevant opportunities for actions in the future. The impacts are considered from the 1990s to the future.

Connectivity has changed the world for good, and its potential is extremely great. This potential will only grow because of the Internet of Things, which will connect physical products as well, and therefore provide smart solutions with the aid of technology. Connectivity and ICT can contribute a lot to reaching the desired sustainable results by helping other industries improve in their sectors (GeSI, 2015).

In the field of economy, the greatest impact of connectivity is visible as the massive financial benefits, new business opportunities and increased efficiency. Improving the level of Internet access would also create new jobs and lift people out of extreme poverty (Deloitte, 2016). It may be possible to generate economic benefits of $11 trillion by 2030 in eight industry sectors (GeSI, 2015). Furthermore, connectivity-enabled circular economy may help boost competitiveness and bring about added economic value (Sitra, 2015).

Connectivity enables contacting people all over the world at any time of the day, which has led to increased knowhow, enabled international teams and working from home. Connectivity also helps to save time and improve the efficiency of industrial processes (Pesonen, 2016 & GeSI, 2015). The IoT can, for example, help benefit from the information received through sensors, save resources and lengthen the lifespan of various machines (Pesonen, 2016).

In addition to saving lives, social impacts vary from easing and accelerating remote communication between people all the way to influencing political changes. Access to information increases the opportunities for people's education regardless of their physical location, and enables children to learn to read even without a school or a library nearby (UNESCO, 2014). The Internet offers the same content to everybody, anytime. This

enables people to access information in many languages, and they may thus claim their rights and use the Internet as a communication channel. This, again, provides more equal opportunities.

Simply improving Internet access could indirectly help save millions of lives in developing countries (Deloitte, 2014). Furthermore, digital healthcare makes it possible to improve quality of life, prevent chronical diseases and maintain health (Deloitte, 2014 & Vuori, 2015). It also enables doctors to perform remote surgeries and people to meet doctors remotely (Vuori, 2015 & Tekniikka&Talous, 2014). Connectivity can, for example, help improve safety at work, and it may prevent up to half a million deaths annually through autonomous vehicles and self-driving cars (Nokia Networks, 2015b).

By 2030, ICT may help to abate CO_2 emissions almost ten times more than is generated by the deployment of it into the environmental field. ICT may help separate economic growth from increasing emissions. (GeSI, 2015.) Improvements in energy efficiency and investing in renewable energy sources have finally paid off: global CO_2 emissions and economic growth were decoupled, as the global GDP kept on rising while CO_2 energy-related emissions stayed flat (International Energy Agency, 2016).

With connectivity-enabled smart solutions it could also be possible to improve agriculture efficiency by 30%, to reduce food waste and to save over 300 trillion liters of water and 25 billion barrels of oil by 2030 (GeSI, 2015). Resource efficiency is extremely important, and due to dematerialization, materials can be used more efficiently and it is possible to use services instead of products (EWWR, 2015). Due to the IoT, the potential of using connectivity and ICT will only grow, and it is possible to make processes more efficient and to save time and money.

There will be also challenges and some clear risks related to connectivity. For example, many of the jobs we know today may disappear (Pohjola, 2014), and the digital divide can prevent some people from benefiting from connectivity and ICT (Digital Inclusion Survey, 2016a). The IoT, again, requires both energy and raw materials, as there will be more devices (Advanced MP, 2013). It is a challenge to answer to the world's growing demand of mobile devices while keeping energy consumption flat. Privacy protection is a major risk in the future, and it should be taken seriously in order to prevent misuse.

Finally, findings show that the positive impacts clearly override the negative, even though the challenges must not be taken lightly. The potential connectivity has in sustainable development is enormous, and it will help to improve on every area. Ultimately, the most significant discovery of this study is that instead of balancing the economic, social and environmental fields, improvements in one field are likely to lead to benefits in the other two fields also, which often creates a win-win-win situation. When balancing has previously meant making compromises between the three dimensions, with the help of connectivity all of the fields can support each other even more and they can even be bundled. Connectivity is, therefore, able to help sustainable development raise up to the next level.

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